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THE *What's New* MAGAZINE

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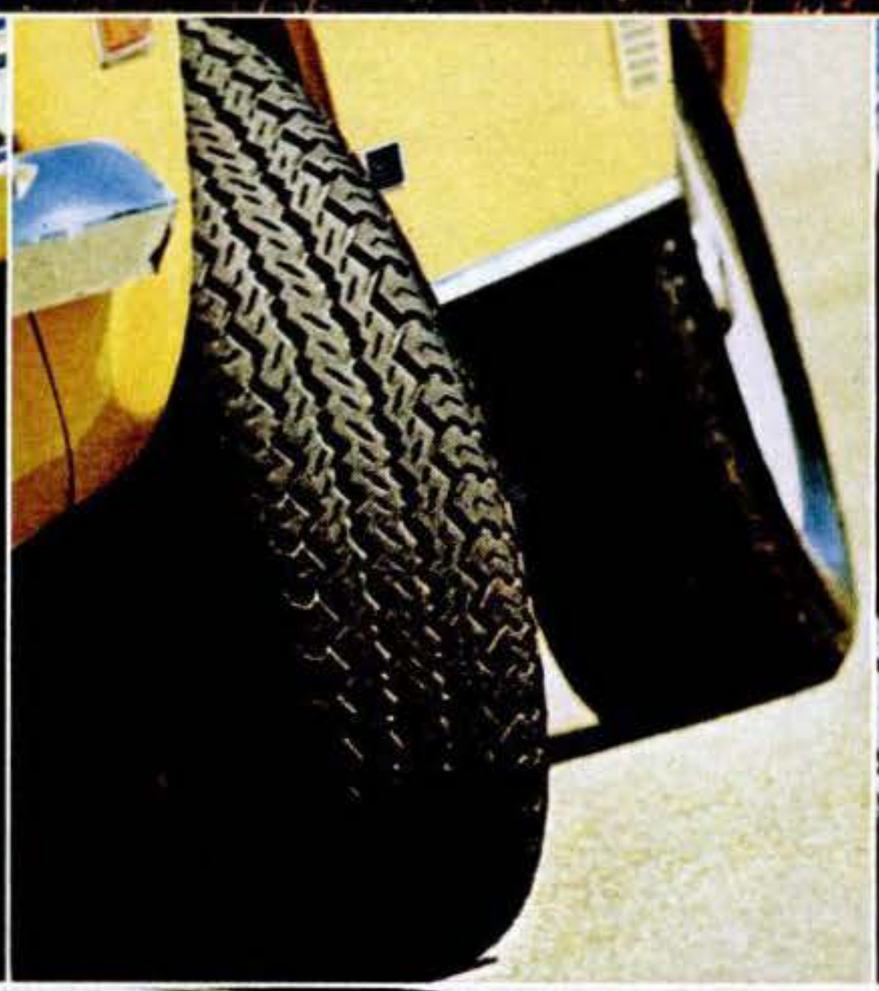

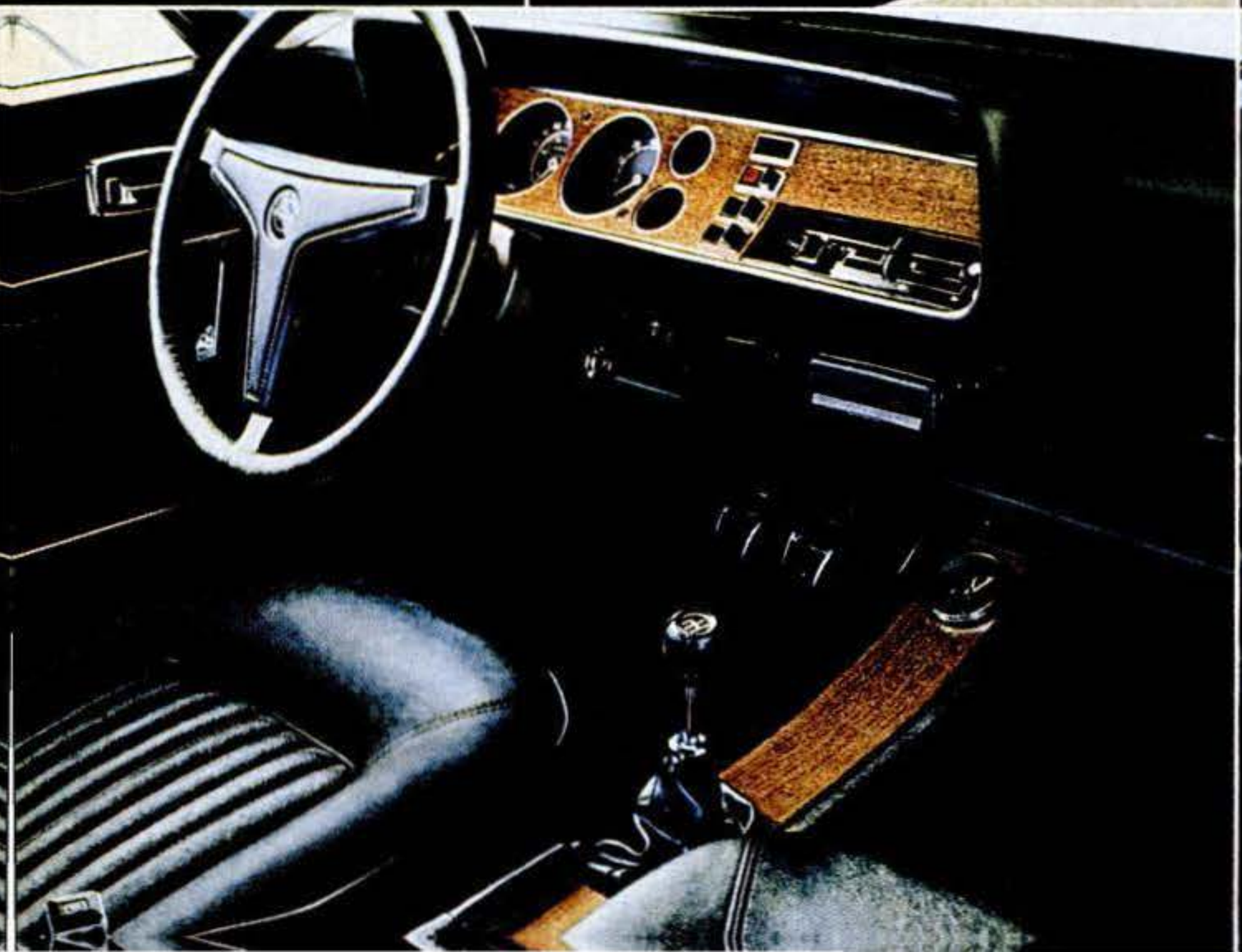

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This One

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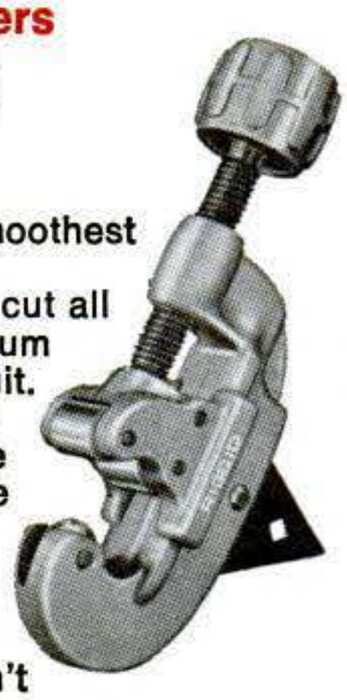
RIDGID Tubing Cutters Give You 3 Tools in 1



Three Sizes For 1/8" through 2 1/8" Tube.

Here are the toughest, smoothest tube cutters available. They quickly and cleanly cut all copper, brass and aluminum tube; also thin-wall conduit. But that's not all, it's also a reamer. The sharp blade folds into the frame where it's out of the way, but always handy. And it's a gas cylinder key too. The key is cut right into the reamer blade so it can't get lost.

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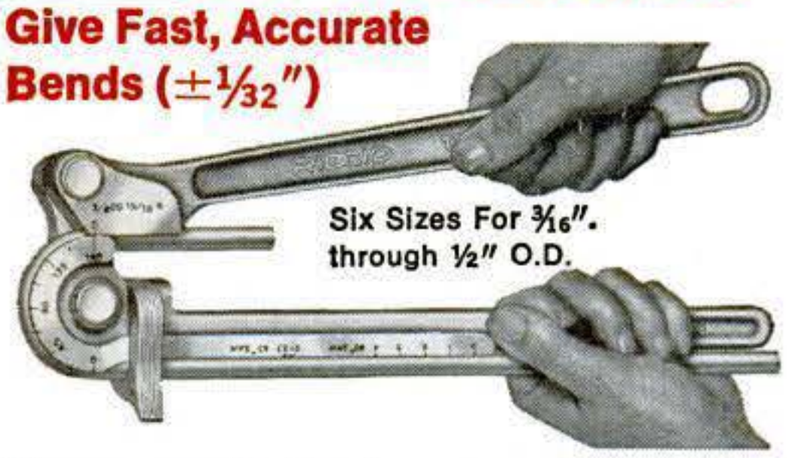

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These versatile benders are extremely easy to use on all soft or hard copper, brass, aluminum, steel or stainless steel tube. Wearing surfaces are hardened for lasting accuracy, long service. Cam-shaped latch with large thumb boss assures easy latching and unlatching. Top of form handle is grooved for positive tube alignment. Gain marks on form handle speed accurate tube measurement . . . no wasted material.

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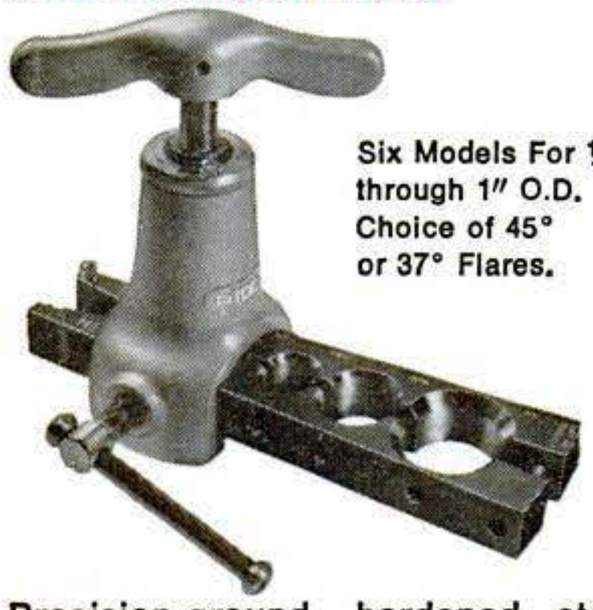

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THE *What's New* MAGAZINE™

FEBRUARY 1972 Founded in 1872/Vol. 200, No. 2

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Norbye and Dunne find surprising value in the new Pinto, Vega, and Gremlin—but, as tested, they aren't cheap.

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It's brighter, cheaper, and far more reliable than your present color tube.

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Striking-looking dome homes are mushrooming as "square" building costs soar.

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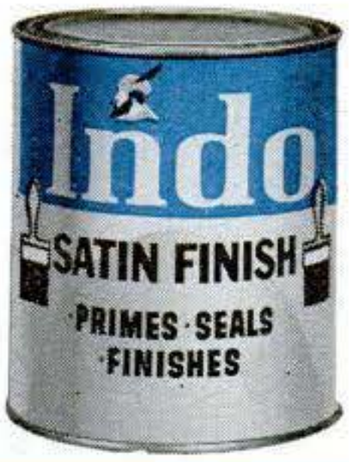

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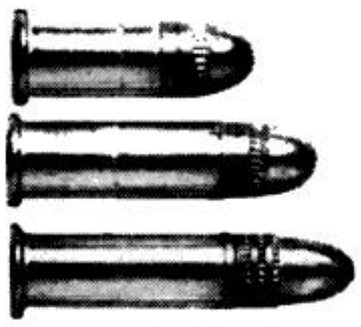
One of a continuing series. **Remington Reports**

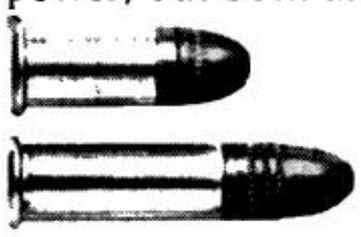
The long and short of rim fire cartridges.

Here's why Remington and Peters make so many different rim fire cartridges, and how you can select the one that's best for the kind of shooting you do.

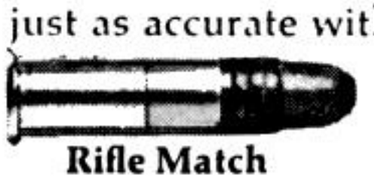
Hard-hitting Remington "Hi-Speed" and Peters "High Velocity" cartridges are designed to give the ultimate in all-round 22 performance and power. In fact, they have more velocity at 50 yards than ordinary 22s have at the muzzle. Their exclusive "golden" bullets are made to mesh perfectly with rifling for greater accuracy. What's more, each bullet is coated with a specially formulated lubricant that gives it a dry, hard surface. All "golden" bullets are clean—and they stay clean. This is very important outdoors, because they won't pick up lint if you carry them loose in your pocket, or get dirty if you drop them on the ground. And, like all Remington and Peters ammunition, they have patented "Kleanbore" priming that provides fast, snappy ignition without causing rust and corrosion in the barrel.



"Hi-Speed" and "High Velocity" cartridges come in specific sizes for specific ranges. For example, the 22 long rifle with a hollow point bullet has a muzzle velocity of 1315 feet per second and is an efficient small-game and varmint getter at 100 yards. You can also use a solid bullet when you're hunting meat for the pot. The 22 long, which is shorter, and the 22 short, which is the shortest and quietest of the three, have slightly reduced power, but both are efficient performers.



Remington and Peters Standard Velocity 22s were designed for short-range hunting and for informal target shooting or plinking. They are available in both 22 long rifle and 22 short sizes with solid lead bullets. Though not as powerful, they are just as accurate within their range.



Rifle Match

Pistol Match

However, serious target shooting calls for Remington or Peters Match Long Rifle 22s. These specialized loads have a bullet shape that's micro-measured for consistency and has superb wind-bucking qualities. They also have a silicone-base lubricant that makes it unnecessary to clean barrels between stages and a close-tolerance brass case with a rim shaped for improved ignition.

All of our ammunition—even our 22s—is matched by design to our guns for the best possible performance. And Remington makes a full line of 22 rifles for beginners to expert marksmen, including bolt, pump and automatic models suitable for use in the field.

But there are some varmint-hunting situations that are literally beyond the reach of even the most powerful 22. Which is why Remington-Peters introduced the new 5mm Remington Rim Fire Magnum—the hardest-hitting rim fire manufactured today. This all-new cartridge starts with a muzzle velocity of 2100 feet per second, and the bullet is still traveling at 1400 feet per second 150 yards down range. Incidentally, it's the only rim fire made with a special "Power-Lokt" hollow point varmint bullet for super-accuracy.

The 5mm Remington Magnum is so powerful, we had to design two new rifles to shoot it: the Model 591 bolt action with clip loading, and the Model 592 bolt action with tubular magazine.

The 5mm Remington is capable of an accurate, clean varmint wallop at 150 yards. It permits the cost-conscious shooter to move into center fire territory with rim fire economy.

Remington Reports is a continuing series based on information straight from the Remington experts who design and engineer all Remington products. If you would like to clip them out to build your own hunting and shooting manual, we'll send you a free Remington Reports binder to keep them in. You can also get a free copy of our new, 48-page color catalog which contains further information about ballistics and our products. To get either, or both, write: Remington Arms Company, Inc., Dept. 417, Bridgeport, Conn. 06602.

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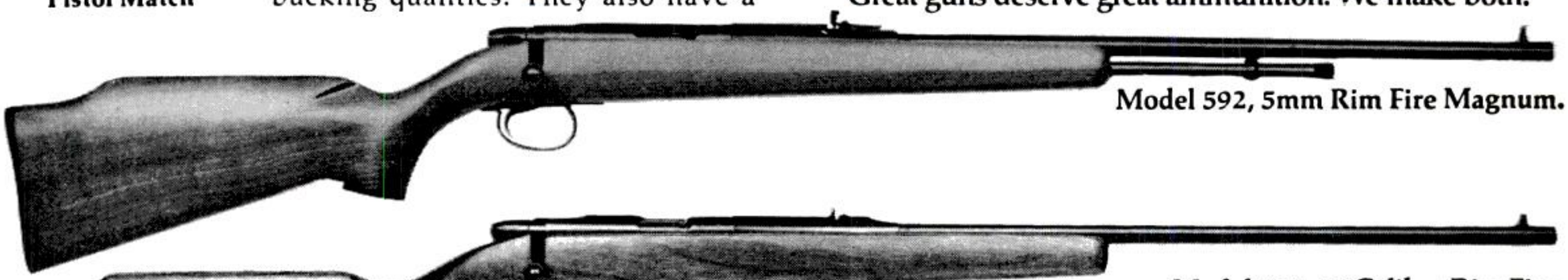

Model 592, 5mm Rim Fire Magnum.

Model 581, 22 Caliber Rim Fire.

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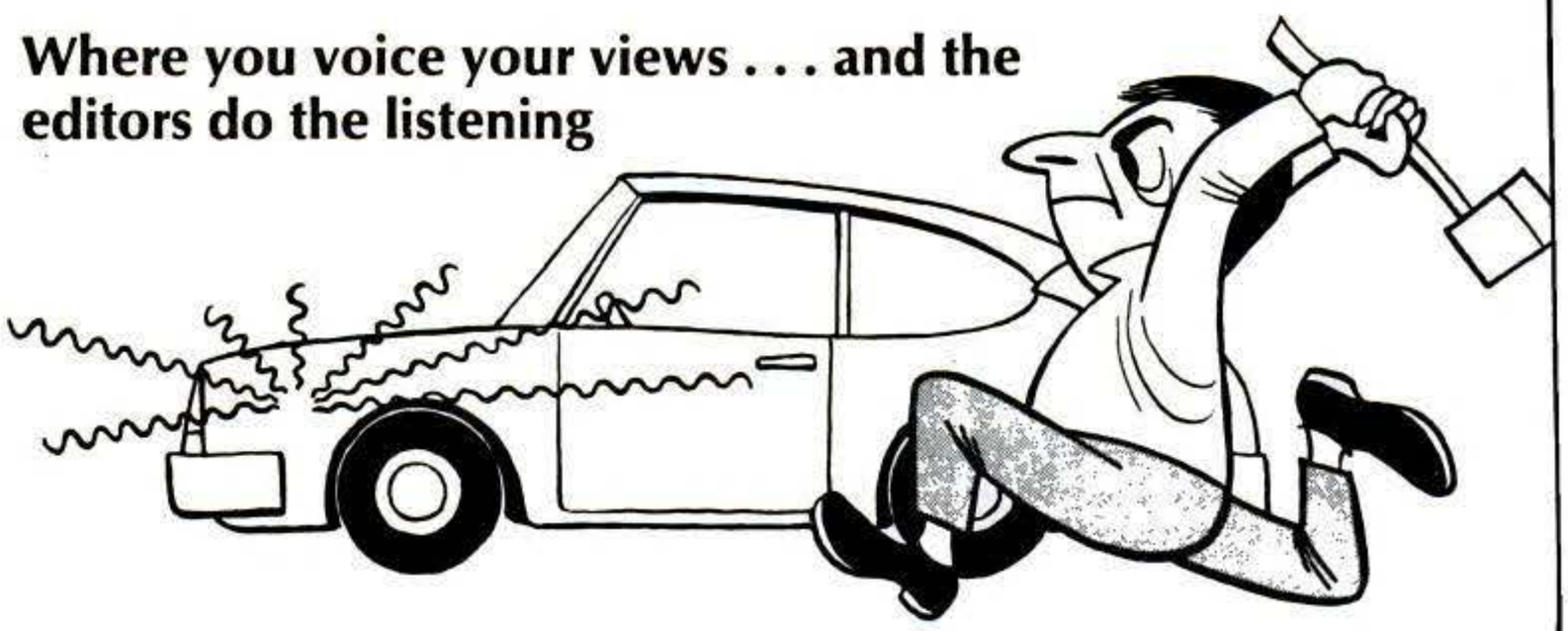
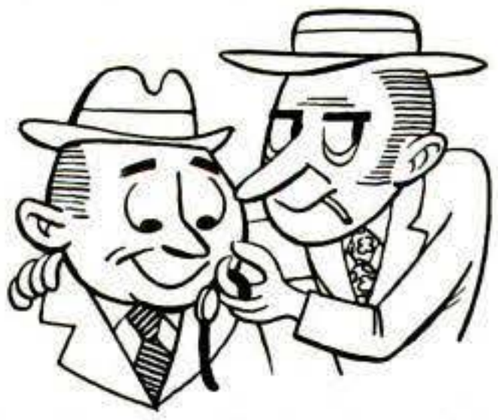


Watch those watches!

Many thanks for your excellent article, "Here's What You Should Know About the Counterfeit-Watch Racket" [Dec.]. Just before the mail arrived with your magazine, I had a customer ask me to appraise his watch. It was a "Hormilton Electra 25" that he purchased for $15. When I told him it was worth about $2, he got angry and did not believe me. Maybe your article will convince him now. The watch companies should buy reprints and send them to jewelers for their customers. Maybe it would break up the racket.

IRVIN FOX, Fox Jewelers, Inc.
Rockingham, N.C.

. . . Shed not a tear for the poor boob who was caught on the phony watch deal. The prime requisite for the con game is a sucker who has larceny in his heart



and is looking for "something for nothing." If he isn't buying a watch, then it's a siding job for his house from a stranger at his door, or an asphalt driveway coating "that's left over from another job." Until he learns never to do business with a stranger, he will go on and on and the only thing that will stop him is when he runs out of money.

A. R. HARTMAN, Boswell, Pa.

Amen!

Auto alarms: readers wail back

"Car Alarm Has Siren Voice" [Nov.] may be an effective deterrent to thieves, but it is unfortunately illegal in California. Section 27002 of the Vehicle Code prohibits equipping any vehicle, other than an emergency vehicle, with a siren. Even though many such alarm systems may not be activated while the car is in motion, the California Highway Patrol interprets the section as prohibiting them altogether. It will issue warnings when one is discovered during a safety check, requiring that they be removed.

A. D. CASTBERG, S. Pasadena, Calif.

. . . I am sure that alarms scare off car thieves, but have you ever stood within a hundred feet of one for more than a few moments? What happens when the owner locks his car, sets the alarm, and goes to another part of the city? I have heard one of these horrors scream right outside my window from 9 p.m. to 7 a.m. Try to sleep through that!

I suggest a self-resetting time relay that will cut off the siren after, say, a minute. That will scare off the thief, and when it resets itself, protection for the car will be maintained and permanent damage to the neighbors' ears will be kept to a minimum. Certainly, if I made any such racket on the street, I would be arrested for disturbing the peace.

HENRY HULME, Brooklyn, N.Y.

PRT (continued)

Paul Wahl, author of the very timely article "Personal Rapid Transit" [Nov.], is to be applauded for the professional treatment of this subject. I've been advocating for years that intracity transportation is no less important than intercity transportation. We must revolutionize our means of moving people and goods on the ground if we are to keep pace with an expanding population. For the overwhelming public benefit, POPULAR SCIENCE should continue to introduce to its readers new concepts of more efficient surface transportation.

F. C. BARRY, Eastern Mgr., Passenger Train Journal, Harrington Park, N.J.

Color-TV converter

There is one statement in "Add-On Converter Turns Your B&W TV into a Color Set" [Dec.] that is misleading and damaging to a fair assessment of our product. It says, "I made an exposure-meter test and found the converter reduces picture brightness by about 90 percent." The color-picture brightness certainly does not appear to be only 10 percent as bright as the original black-and-white picture when viewed on your cover picture. This arises from the fact that visual responses are of logarithmic form. Also, we are adding color information to the picture, so the high range of brightness of the original black-and-white picture is not required for the eye to distinguish between different objects.

Taking all of the above into account, and after asking a number of nontechnical people to assess the relative brightness, we feel that a fair statement would

[Continued on page 10]

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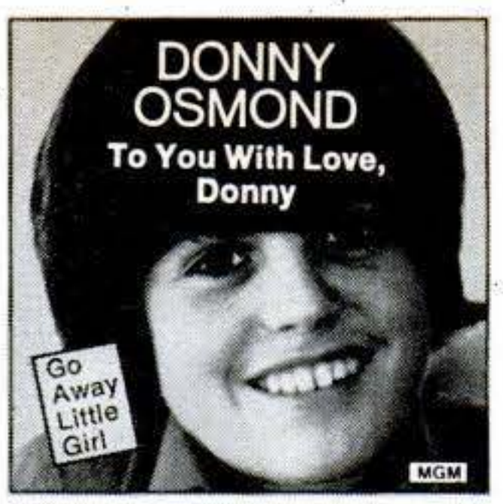

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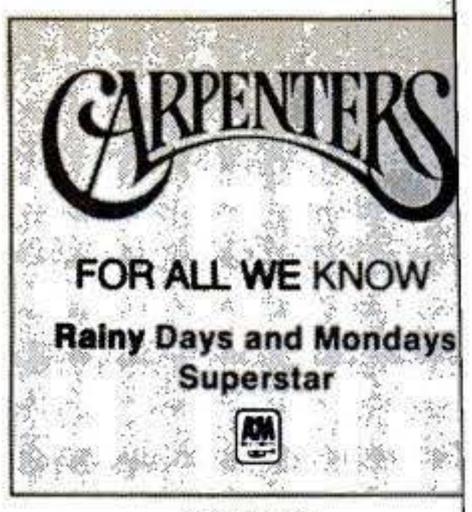

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Any 14 records–$2.86

if you join the Columbia Record Club and agree to buy ten records (at regular Club prices) in the next two years

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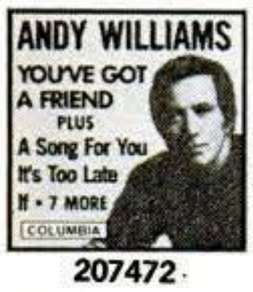

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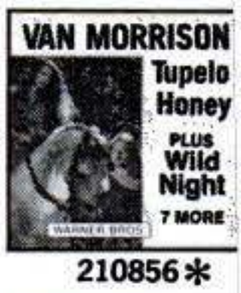

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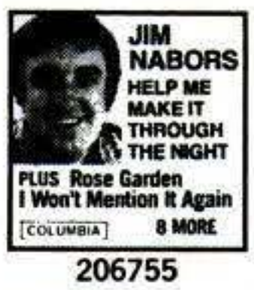

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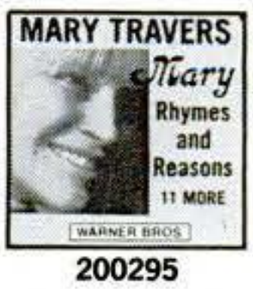

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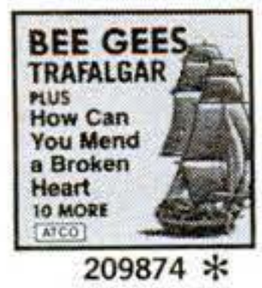

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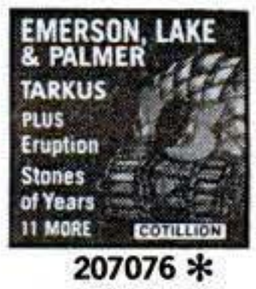

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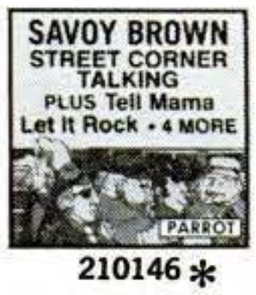

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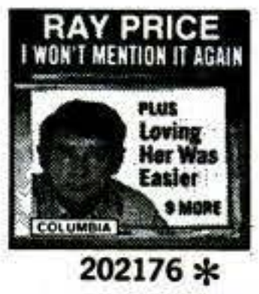

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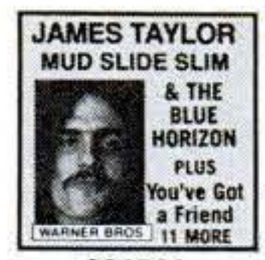

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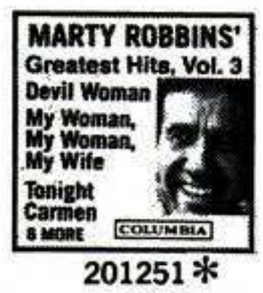

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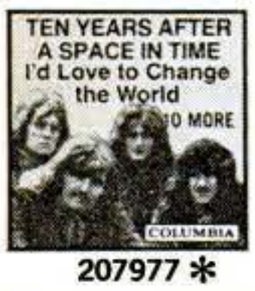

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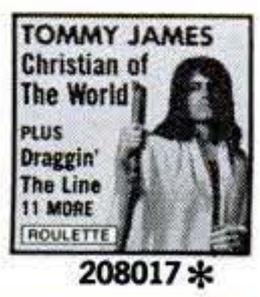

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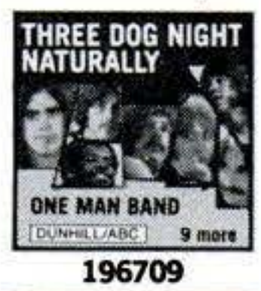

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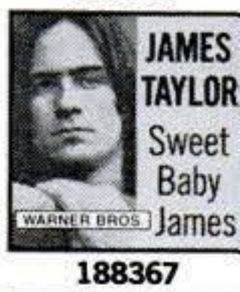

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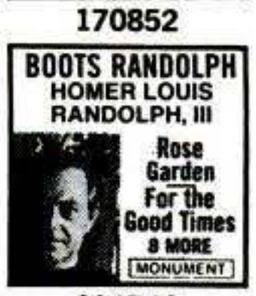

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* Selections marked with a star are not available in reel tapes.

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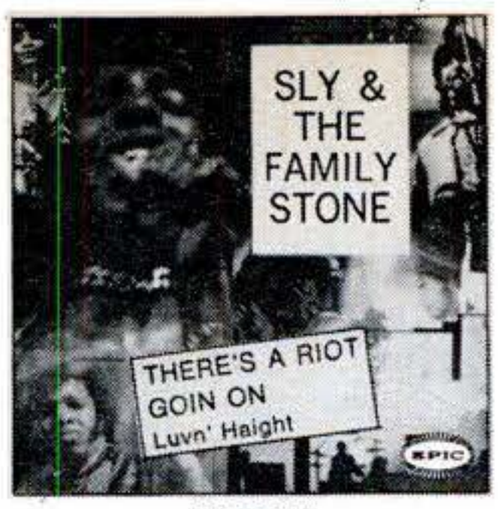

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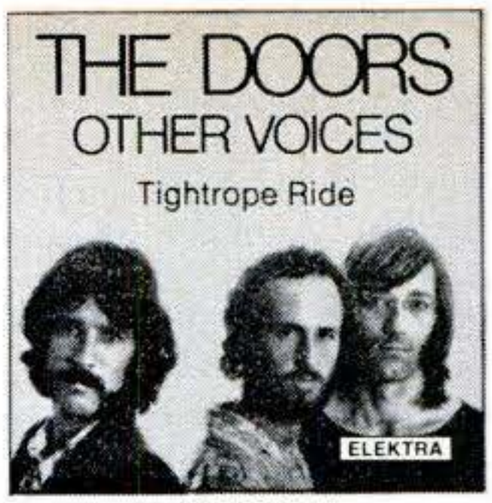

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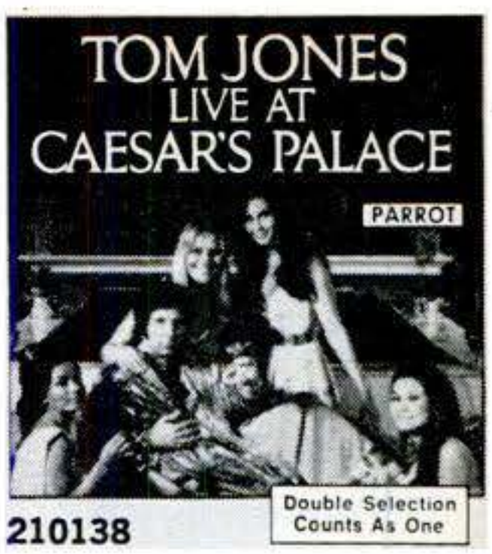

210138

OR Any 8 tapes-$2.86

if you join the Columbia Tape Club and agree to buy seven tapes (at regular Club prices) in the next two years

207993

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210153

TAKE YOUR PICK OF TAPES

8-track cartridges OR tape cassettes OR 7" reel-to-reel tapes

208363

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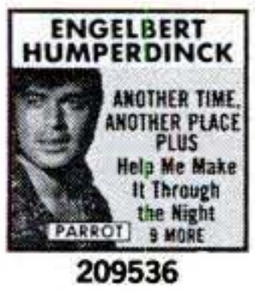

209536

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MORE DOUBLE SELECTIONS
2-record sets or twin-pack tapes—yet each double selection counts as only one!

210161

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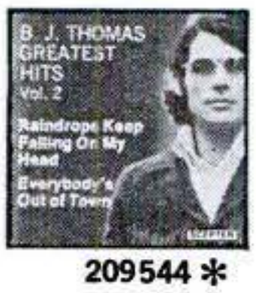

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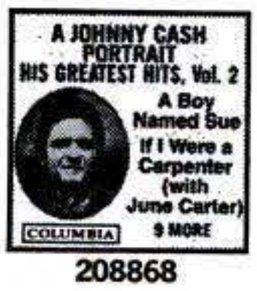

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209957 *

186809

Just look at this great selection of recorded entertainment — available on 12" Records *OR* 8-Track Cartridges *OR* Tape Cassettes *OR* 7" Reel Tapes! So no matter which type of stereo playback equipment you now have — you can take advantage of one of these introductory offers from Columbia House!

If you prefer your music on 12" Stereo Records join the Columbia Record Club now and you may have ANY 14 of these selections for only $2.86. Just indicate the 14 records you want on the application and mail it today, together with your check or money order. In exchange, you agree to buy ten records (at the regular Club prices) during the coming two years . . . and you may cancel membership any time after doing so.

OR — if you prefer your music on Stereo Tapes join the Columbia Tape Club now and take ANY 8 of these selections for only $2.86. Just write in the numbers of your 8 selections on the application — then mail it together with check or money order. (Also indicate whether you want cartridges *or* cassettes *or* reel tapes.) In exchange, you agree to buy seven selections (at regular Club prices) during the coming two years . . . and you may cancel membership any time after doing so.

Your own charge account will be opened upon enrollment . . . and the selections you order as a member will be mailed and billed at the regular Club prices: records, $4.98 or $5.98; cartridges and cassettes, $6.98; reel tapes, $7.98 . . . plus a processing and postage charge. (Occasional special selections may be somewhat higher.)

You may accept or reject selections as follows: whichever Club you join, every four weeks you will receive a new copy of your Club's music magazine, which describes the regular selection for each musical interest . . . plus hundreds of alternate selections from every field of music.

. . . **if you do not want any selection** in any month, just return the response card always provided by the date specified

. . . **if you want only the regular selection** for your musical interest, you need do nothing—it will be shipped automatically

. . . **if you want any of the other selections offered,** order them on the response card and return it by the date specified

. . . **and from time to time** we will offer some special selections, which you may reject by returning the dated response form provided . . . or accept by simply doing nothing.

You'll be eligible for your Club's bonus plan upon completing your enrollment agreement — a plan which enables you to save at least 33% on all your future purchases. Act now!

Columbia House
Terre Haute, Indiana 47808

B61/S72

COLUMBIA HOUSE, Terre Haute, Indiana 47808

I am enclosing check or money order for $2.86, as payment for the 14 records indicated below. Please accept my membership application for the **Columbia Record Club.** I agree to buy ten records (at regular Club prices) in the coming two years — and may cancel membership at any time after doing so.

RECORDS

MY MAIN MUSICAL INTEREST IS (check one box only) **(BS-Z) AY6**

☐ Easy Listening ☐ Young Sounds ☐ Classical
☐ Broadway & Hollywood ☐ Country ☐ Jazz

OR TAPES

I am enclosing my check or money order for $2.86, as payment for the 8 tapes indicated below. Please accept my membership application for the **Columbia Tape Club.** I agree to buy seven tapes (at regular Club prices) in the next two years — and may cancel membership any time after doing so.

SEND ME THE FOLLOWING TYPES OF TAPES (check one box only) **AY6**

☐ Cartridges (PN-W) ☐ Cassettes (PP-X) ☐ Reel Tapes (MH-Y)

MY MAIN MUSICAL INTEREST IS (check one box only)

☐ Easy Listening ☐ Young Sounds ☐ Country

Whichever Club I've joined, all selections will be described in advance in the Club magazine, sent every four weeks. If I do *not* wish any selection, I'll return the card provided by the date specified, or use the card to order any selection I do want. If I want *only* the regular selection for my musical interest, I need do nothing — it will be shipped automatically. Occasionally, I'll be offered special selections which I may accept or reject by using the dated form provided.

☐ Mr.
☐ Mrs.
☐ Miss.....
(Please Print) First Name Initial Last Name

Address.....

City..... State & Zip.....

Do You Have A Telephone? (check one) ☐ YES..... ☐ NO

APO, FPO addressees: write for special offer

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In squirt cans or spray cans.

G-P GENERAL PURPOSE DEGREASER GUNK G-P (liquid) cleans power mowers, garage floors, machinery.

GUNK BO-2K professional carburetor and small parts cleaner for home workshop.

S-C SUPER CONCENTRATE Dilutes with 10 parts kerosene for degreasing at lowest cost.

GUNK LABORATORIES, 5829 W 66th, Chicago, Ill. 60638
GUNK CHICAGO CO. River Forest, Ill. RADIATOR SPECIALTY CO. Charlotte, N. C.

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Liquid WRENCH DEODORIZED THE SUPER PENETRANT FREES RUSTED BOLTS AND PARTS It melts the rust away! DANGER-FLAMMABLE KEEP FROM HEAT OR FLAME HARMFUL OR FATAL IF SWALLOWED CONTENTS UNDER PRESSURE NET WT. 12 OZ. AV. (15 FL. OZ.)

in spray cans or squirt cans.

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TRANS MEDIC Stops transmission troubles, Eliminates slippage, down-shifting.

LAN-LIN Quickly removes grease, grime, paint, stains.

RADIATOR SPECIALTY COMPANY
Charlotte, North Carolina 28201

PS Readers Talk Back

[Continued from page 6]

be that the picture appears to be about one-third as bright as the original black-and-white picture, and the picture is enhanced by the addition of color. While we do not claim our converter produces as bright a picture as expensive color-TV receivers, it does produce a satisfactory color picture.

F. V. TOPPING, President, Spectrac Ltd., Scarborough, Ont.

Adhesives—a sticky story

"All You Need to Know About Adhesives" [Dec.] was most helpful and com-

the shelf life of the individual adhesives, or at least of the various types.

In my own adhesives drawer are at least 20 kinds of adhesives, most of which have been on hand for over two years. It certainly would be helpful to know which, if any, might still be usable and which should be discarded. Perhaps I'd better throw away the whole lot.

It would be nice if manufacturers would print an expiration date on each package, as do manufacturers of photographic materials. If you buy an adhesive today, there is no way to tell when it was manufactured, or how long it was on distributors' and retailers' shelves.

THOMAS HASLAM, Marshalville, Ga.

Transparent air bags in your car?

To reduce "public mistrust of the whole air-bag system" [Detroit Report, Dec.], General Motors and other auto companies might wish to consider transparent plastic. Its use might prevent or reduce the traumatic experience of an opaque barrier appearing almost instantly in front of driver or passenger in a collision.

REG WASHBURNE, Plainfield, N.J.

Lightweight steam engine

Your article "Say Smokey . . . A Steam Engine?" [Dec.] says the Oliver-Yunick external-combustion engine weighs "about five ounces per horsepower." Hard to believe. Your pictures belie that statement. Didn't E. F. Lindsley see anything wrong with such a statement?

W. M. KIRLIN, Philadelphia, Pa.

Lindsley replies: "No brag—just fact. The engine shown is hand-built, mostly of aluminum tubing. On accidental overspeed, the five-ounce-per-horsepower figure (engine only) has been bettered. Don't forget, you'd have to add boiler, burner, condenser, and plumbing into the total weight. The brass model, built to show the concept, is in no way representative of the structural mass of a working model."

Does it pay to buy special tools?

In "Exhaust-System Service Center for Your Car" [Nov.] you fail to reveal a source of supply for the tools. Although the savings in a do-it-yourself project are well worth the time and effort, many people do not have the frequency of use required to justify such an investment. For these people, a similar muffler-installation kit is available from Sears for a reasonable deposit. Anyone who has struggled with an exhaust system will find these tools an absolute necessity.

There was a lack of emphasis on the need for proper blocking of the car. Many readers do not own jack stands and should substitute cement blocks or something better than a bumper jack.

S. NEU, Marilla, N.Y.

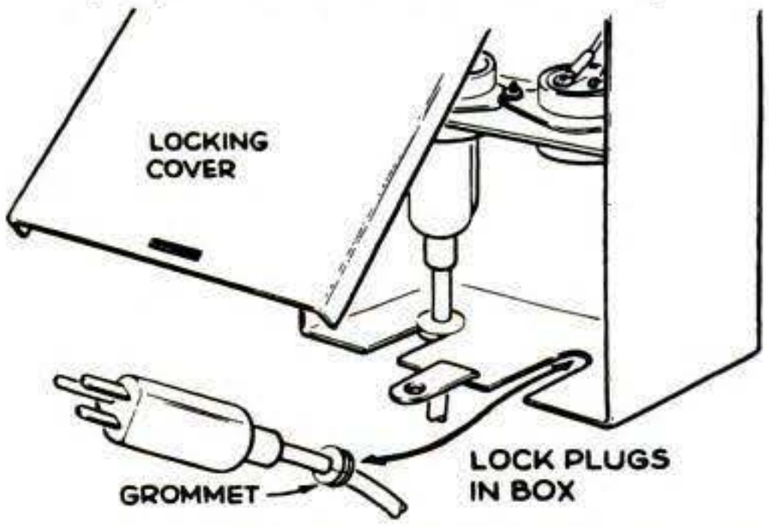
Locking up your tools

I was quite interested in "How Electronics Can Lock Power Tools" [Dec.], but I would like to point out a slightly confusing error. On page 99, the last paragraph in the first column reads, "Press switch S2 . . ." It should be S9.

STEVEN WOLFE, San Diego, Calif.

You're right. It's a goof.

. . . It would be a shame to go through all the trouble to build an electronic lock for power tools only to have a youngster with common sense run an extension cord to one of those neatly displayed plugs hanging down from the control box. There should be some way to lock the plugs inside the box. Here's my idea:



GEORGE STURGIS, Naples, Fla.

. . . I have started to build the electronic power-tool lock for my shop, but I cannot seem to locate the 1N70 diode. Is there a substitute I can use?

JOSEPH BECZE, Old Bridge, N.J.

Yes. The diode serves as a protection device in the circuit to keep a high voltage transient (called back EMF) from entering the SCR whenever the relay is switched off. Just about any general-purpose diode will work in its place. A 1N60 should do the trick.

A good word for Wordless

I would like to commend you on the practical hints that you illustrate in "Wordless Workshop." Cartoonist Roy Doty makes his ideas practical, economical, and easy to follow with light touches of humor. Keep the ideas coming.

GEORGE EWING, Amarillo, Tex.

Want to get something off your chest? Write "Readers Talk Back," Popular Science, 355 Lexington Ave., New York, N.Y. 10017.

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Look and Listen

News, comment, and opinion from the world of home-entertainment electronics

By C. P. GILMORE

Wall-sized TV?

Several companies in this country and abroad have demonstrated large-screen projection-TV rigs, but they've all been terribly expensive and huge consumers of power—totally impractical for home use. That may be changing. The audio pioneer who almost singlehandedly brought about the stereo-compact revolution and who was a major force in the struggle to make the cassette a quality-music medium has now turned his hand to projection TV. The man is Henry Kloss, president of Advent Corp., who says the new system will go into production in 1972 and will produce a picture 4.5 feet high and six feet wide. Cost at first will be a no-nonsense $2,500, but should drop below $1,000 within a reasonable period.

An answer to stereo snatching?

As you may have learned the hard way, installing a stereo radio or tape deck in your car is practically asking for burglary, and the industry is afraid many potential customers are not buying mobile stereo for fear of theft. Now, a new outfit called Audio Insurance Associated of Los Angeles will sell you theft insurance for your car stereo for $5 to $10 a year, depending on value. To make it easy to get—and to increase the sales of sets—they're putting self-addressed envelopes and fill-in application forms next to car-stereo displays in radio and TV stores and auto-accessory dealers.

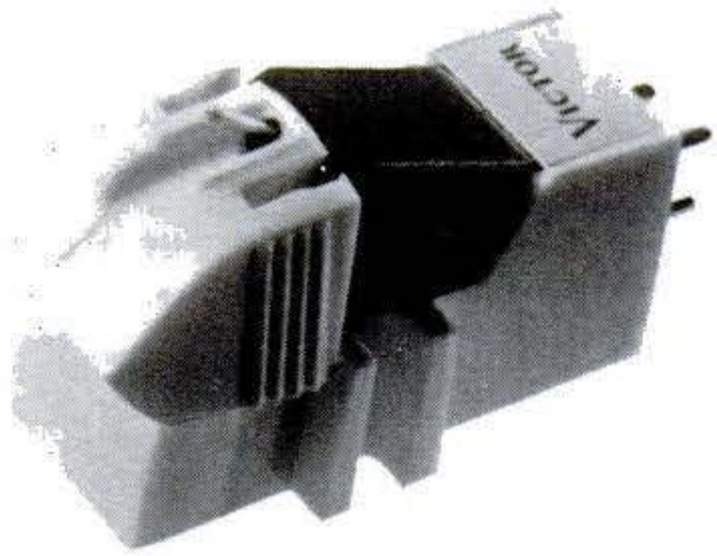
From confusion to chaos

You may remember my optimistic report last month that the various manufacturers are making progress toward a standard matrix system, and thus the whole four-channel mess would soon be straightened out. Well, forget it. RCA Records, Panasonic, and JVC of Japan recently summoned reporters to the plushy Sky Club 56 stories above Grand Central Station in New York's Pan Am building to announce that: 1) the JVC discrete-four-channel disc first demonstrated about a year ago is now close to commercial practicality; 2) Panasonic and JVC are now designing a full line of equipment for playing the four-channel disc; and 3) both records and equipment will be on the market in the "not-distant future." Thus the four-channel situation, which seemed on the verge of resolution, is blown wide open again. (Below: one Panasonic system.)

The JVC system, you may remember, shoehorns four discrete signals into one record groove by the well-known, clever technique known as multiplexing. The two front-channel signals are recorded exactly as they are on a standard stereo disc—by recording the two different signals on the opposite sides of the V-shaped groove. The two rear-channel signals are then piggybacked on a high-frequency carrier, and this composite signal is recorded on top of the original signal. The scrambled signal is separated into the four original sound tracks by a decoder circuit.

The system works well indeed. Hugo Montenegro, who was at the news conference, introduced several selections that he had arranged and recorded specially for the new system. The instruments appeared to be located in a complete circle around the audience, and the placement of each instrument was precise. And it stayed in its place even as listeners walked around.

So it works. But that's not the end of the battle. Both the JVC discrete disc and the matrix system (espoused in one form or another by Columbia, Sony, Electro-Voice, Dyna, Sansui, and others) have definite advantages and disadvantages. The JVC disc, for example, gives better four-channel separation. This appears to me to make the listening position less critical than with the matrixed records. But the JVC discs cannot be broadcast over FM. The JVC

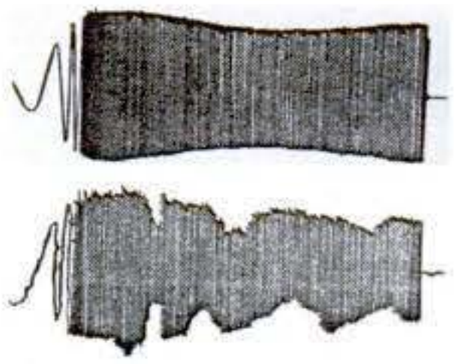


record requires a special cartridge, while the various matrixed records will play with the cartridges now in use. And the matrixes give some four-channel effect even from conventional stereo records, tapes, and broadcasts.

The biggest disadvantage of the JVC disc appears close to solution. When the JVC record was first introduced

Continued

Cassettes—the inside story



What's the difference between blank cassettes that sell three for a dollar and the $3-each kind? Makers of the quality units have been trying to get that story across for years—not always successfully. But Maxell Corp. may have finally figured out a way to convince the paying customer that there is a difference.

The company has put together a logarithmic-sweep generator (it sweeps through a band of frequencies from about 20 to 20,000 Hz) and a storage oscilloscope. With this rig a demonstrator can make instantaneous comparisons between various kinds of tape. The top sweep shows what a first-class tape (Maxell in this instance) looks like. At bottom is a three-for-a-dollar cheapy. The jittery line at the left is caused by a wobbling cassette hub. Frequency response is poor, the rough edges show high noise level, the irregular gaps are dropouts from poor oxide coating, the spikes show binding. The setup has drawn a lot of attention in retail stores where it has been demonstrated and has no doubt upgraded the tape-buying habits of those who have seen it.

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This clock radio not only gives you the time of day, it gives you the day. And the date. And FM. And AM. And extras like an extra-big speaker. And extra-wink nap control. The Panasonic "Digi-Dater," RC-6551. It's everything you've always wanted to know about time — but were too tired to find out.

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Finally, a clock radio for the Good Tooth Fairy.

Now under the pillow, besides quarters and teeth — FM and AM. Because this Panasonic has a separate pillow speaker. And a Sure-Awake system that turns on the main speaker automatically. Check out the "Planada," RC-7589. It's time you had something going under your pillow for a change.

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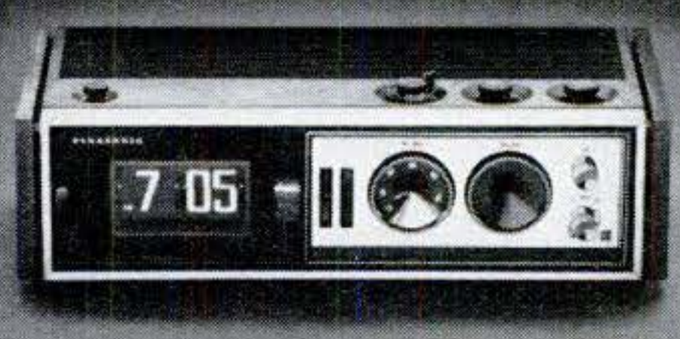
How to tell your AM from your FM at 7:05 in the morning.

When you finally pry an eye open, you'll find one staring back. Because, along with the big readable numbers, each tuning dial lights independently on this Panasonic. And whichever you're seeing, you'll be hearing a lush big-set sound. So look for the "Cameron," RC-7469. It not only wakes you up—it lets you know where you're at.



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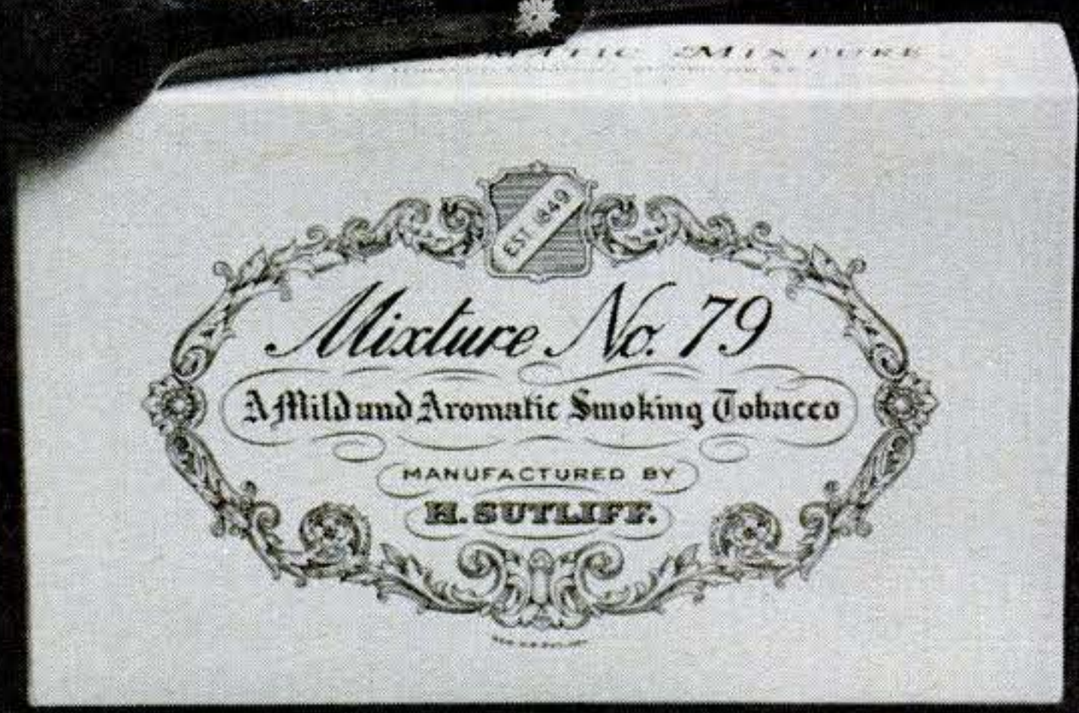

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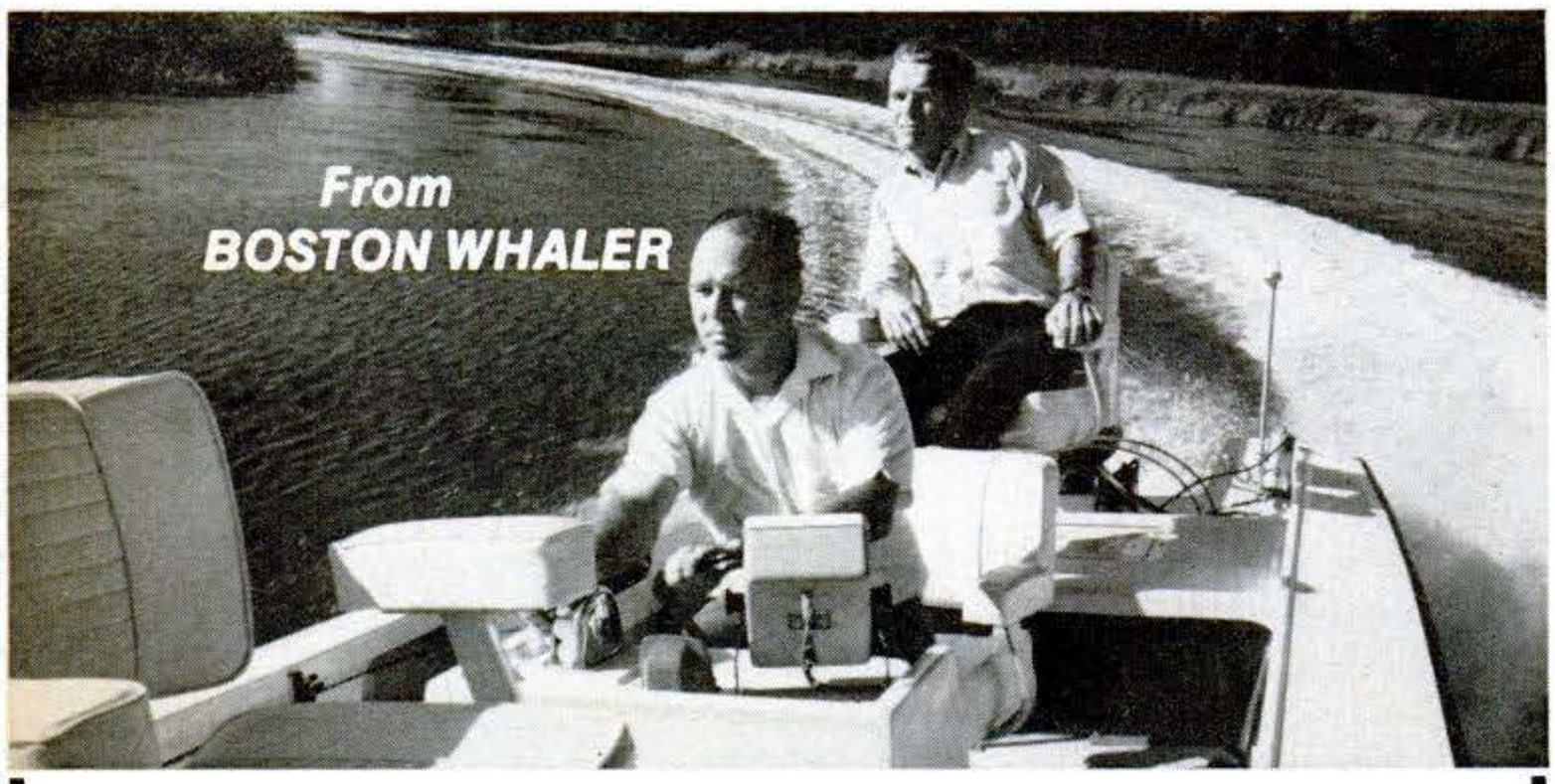

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Look and Listen

[*Continued*]

last year, it was good for only a few plays. All of those tiny high-frequency signals containing the back-channel information were simply wiped out of the groove after a few times around. According to officials at the news conference, that problem is almost licked.

So the fight is on, and no doubt a lot of manufacturers already on the fence about four-channel are now more than ever determined to stay there—at least until the new JVC/RCA four-channel records and the Panasonic and JVC equipment to play them on are available. Everybody at the conference was cagey about just when that might be, but best guess is somewhere around mid-1972.

On the record

I recently got some of the RCA four-channel cartridges that have been around a while, including Tchaikovsky's *Symphony No. 6* (Philadelphia Orchestra, Ormandy, RQ8-1112); Stravinsky's *Firebird Suite* and *Petrouchka* (Boston Symphony, Ozawa, RQ8-1164); *The Best of Arthur Fiedler and the Boston Pops* (RQ8-1047); *The Sound of Music*, original soundtrack (OQ8-1001); *Hair*, original Broadway cast (OQ8-1038); and *The Best of Al Hirt* (PQ8-1011). Most successful are the last three, particularly *The Sound of Music* and Al Hirt. *Hair* is an interesting recording, but I find it a little disconcerting to hear occasional voices zapping me from behind. The Boston Pops concert comes off well in four-channel, too, with the usual spirited playing from Fiedler and Co.

The Tchaikovsky and Stravinsky were somewhat disappointing. The four-channel technique does give a nice, open hall sound. And the readings are first-rate. But there is simply no dynamic range. And in certain passages—the splendid third-movement march of the Tchaikovsky, for example—there is muddiness instead of sound as crisp as cracking ice.

● SMETANA, *My Fatherland*. Boston Symphony, Rafael Kubelik. DGG 3581 008.

Spine-tingling performance of Smetana's passionate symphonic-poem cycle. Recording: a super cassette.

● *Greatest Hits from Fantasia*. Various conductors and orchestras. RCA RK-1214 (cassette); R8S-1214 (cart.).

Old favorites from the 1940 Disney movie. Recordings: satisfactory. Awkward track switches in the cartridge. *Cassette reviews by Ken Furie—*

● DEBUSSY: *Images for Orchestra* (complete), *Prelude to "The Afternoon of a Faun."* Boston Symphony, Michael Tilson Thomas. DGG 3300 187.

Bravo! Performances could be tighter, but this miraculous music is stunningly reproduced—even the hiss is bearable.

● *Birgit Nilsson Portrait* (arias from *Don Giovanni, Oberon, Tannhäuser, Tristan;* "Ah! perfido"). DGG 3300 188.

An odd portrait: Only Isolde numbers among Nilsson's great roles. Yet both Wagner excerpts are glorious, the rest uneven but compelling. No texts. PS

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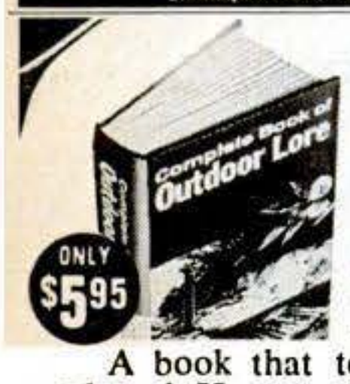

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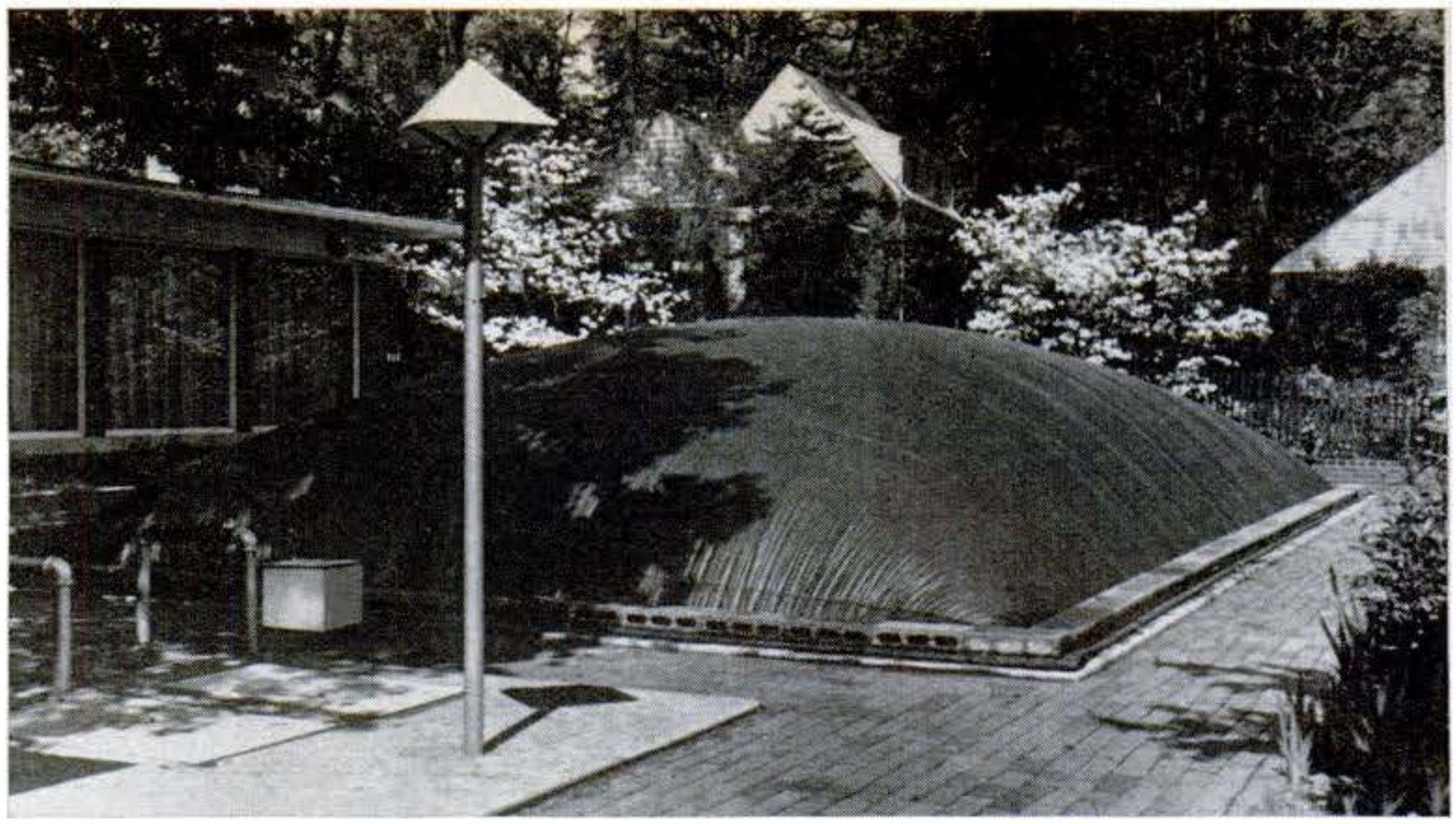


Plastic cover balloons up like this when large electric fan blows in air. The dome stayed clear of snow even in 15" fall last season. Snow slides or blows off.

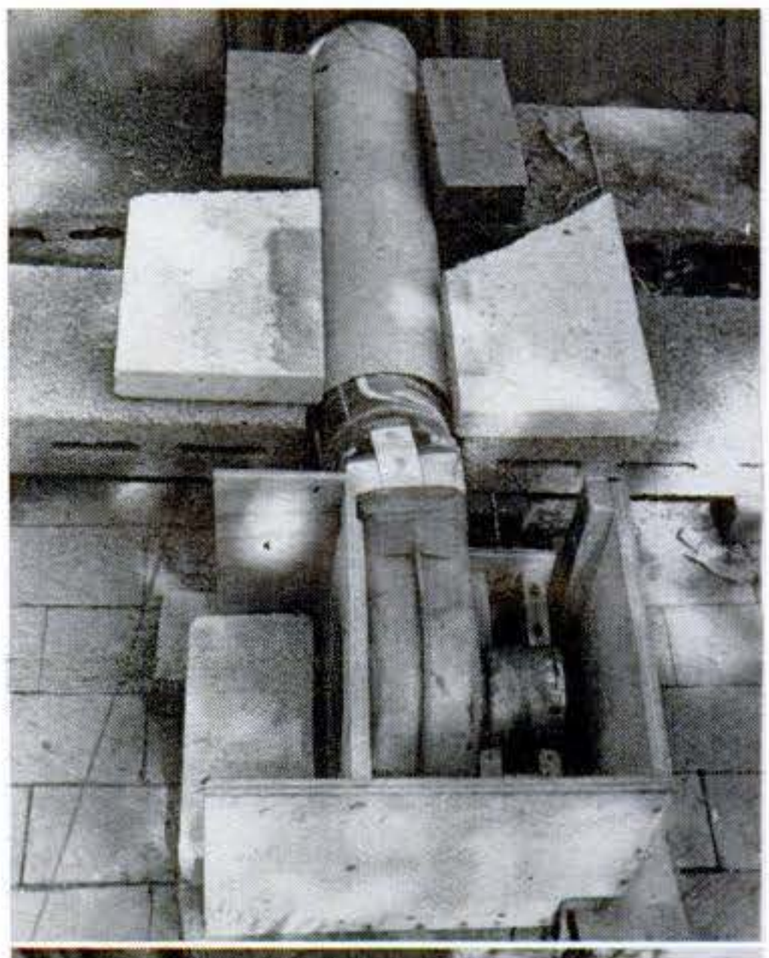
Air-House Pool Cover Sheds Winter Snows

Before next winter arrives, home owners who cover swimming pools each fall may want to take some tips from B. M. Shepard, of Silver Spring, Md. He covers his in-ground pool with a simple air house. After blanketing the pool with a large sheet of plastic, he battens down the edges and arranges a fan to blow under and support the plastic. Flexing of the domed cover causes snow to blow or slide off as fast as it falls.

This type of cover could be used on either an in-ground or above-ground pool. In preparation, you would need to pump out only enough water to empty any circulating pipes that might be damaged by freezing. A heavy dose of chlorine will keep the water clear over winter.

Air leakage is minimal in the prototype cover, and even small holes are no problem. The cover material is light, and the air stream quickly balloons it up. Edges must be battened down carefully, however, or winds will flap the cover and cause the edges to work loose.

The material used for the Shepard cover is Griffolyn Type 55 Black. This can be ordered at four cents a square foot (plus shipping) from the Griffolyn Co., Box 33248, Houston, Tex. 77033. Add at least 10′ to each dimension of the pool when measuring to allow for wrapping the planks and for ballooning.—*R. P. Stevenson*



Squirrel-cage electric fan enclosed in a plywood box provides air flow through duct made of stove pipe with coffee-can-and-tape joints. Arrangement was quickly cobbled up—but it works. Bricks and cinder blocks support and hold down the blower.

Edges of cover are wrapped around 1"-by-8" planks on the pool coping. Cinder blocks placed end to end hold down folded edges.

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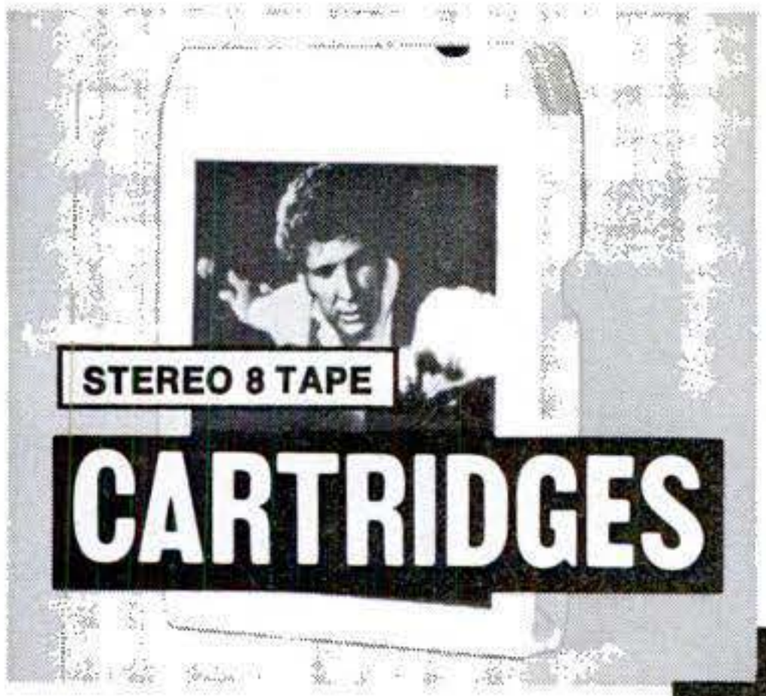

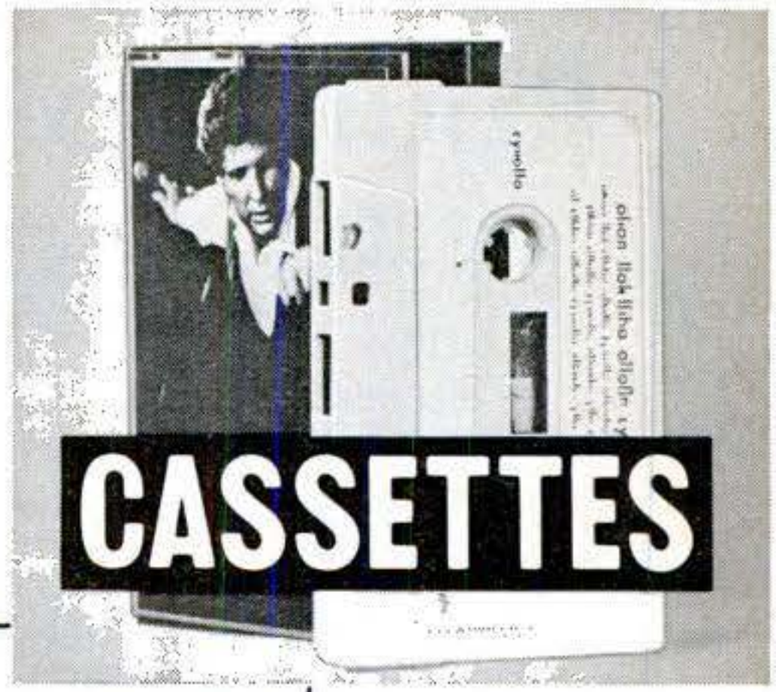

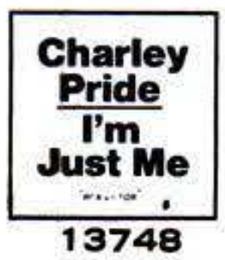

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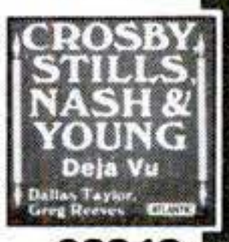

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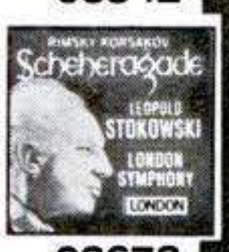

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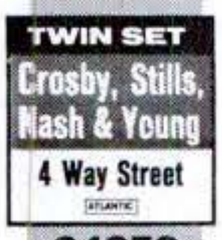

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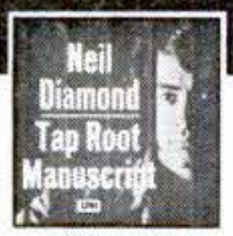

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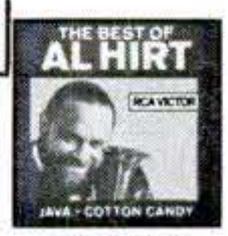

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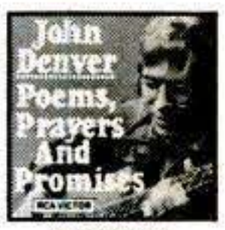

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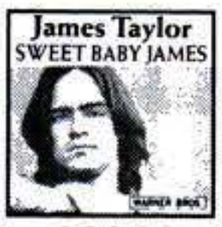

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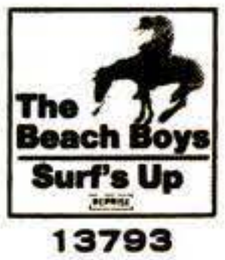

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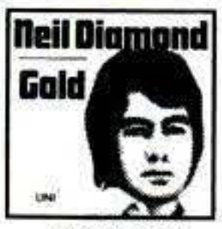

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Recreation Roundup

. . . on the go with PS

By HERBERT SHULDINER

Self-storing awning rolls out plenty of shade for campers

The Inst-Awn is a new convenience for RV owners. The awning comes in a compact weatherproof case which holds shade and support poles when you're on the road, opens in minutes when you set up camp. Made by Inst-Awn Inc., 1027 E. South St., Anaheim, Calif. 92805, it comes in six- to 12-foot widths to fit most recreational vehicles.

'72 Recreational-vehicle preview

Next season's RVs continue a trend toward bigness and luxury in portable vacation shelters. That's the impression I got as I previewed over 1,300 models displayed by 165 manufacturers at the sprawling Recreational Vehicle Institute's annual show in Louisville, Ky., recently.

Even tent campers, the "simplest" RVs, show a surprising amount of self-containment—enough to make most of them look more like plush cabins than campers.

Many manufacturers tell me they're just giving their customers what is demanded. Actually, they admit that the household-type components are designed to convert reluctant wives, who hold veto power on many RV purchases and are encouraged by the convenient comforts.

The female-oriented styling in all types of campers is evident in more colorful draperies and upholstering, more complete galleys, bigger closets and storage bins, brighter lighting.

As you get into bigger RVs, especially trailers and motor homes, the luxury race accelerates. These vehicles are taking on the look of land yachts with staterooms, full baths, complete kitchens, and family-room decoration.

The newest trend in recreational vehicles is the fifth-wheel trailer. I saw more than a dozen new ones at the show. They give you a lot of room and a proven-safe towing method, but they can be towed only by pickups—which can seat only three campers.

Window kits for van conversions

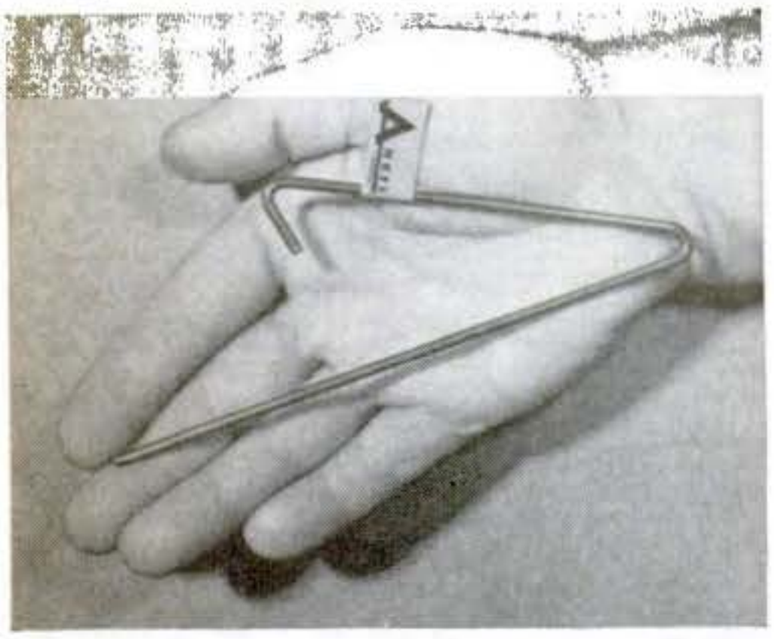
More items that can be used to help convert vans into campers are becoming available to do-it-yourselfers. One of the newest is this streamlined radius window, which the manufacturer claims can be installed in just 20 minutes. The window comes in a kit with all parts necessary for installation, and complete instructions. The only tools required are a screwdriver and saber saw. The window has an anodized aluminum frame, fitted with a theftproof lock and a removable fiberglass screen. Write Meksol Co., 865 W. 17 St., Costa Mesa, Calif. 92627, for a free catalog giving sizes and prices.

Van rolls on six wheels to carry more weight for campers

Watch for campers with four wheels at the rear. Dodge unveiled the dual-rear-wheel unit below at the recreational-vehicle show. Designed for compact-camper builders, the forward section is similar to the single-wheel-rear-axle MB300.

The unit is rated for 8,300 GVW, compared to 8,200 for the standard van. Wheels (seven) are 16.5 x 6.00; tires (six) are 8.00-16.5-C. Standard with the axle option is a 5,800-pound-capacity Spicer 60 H-D rear axle with 4.1 ratio. The front axle carries the same 3,300-pound capacity as the standard van. The new dual-rear-wheel van should allow mini-motor-home makers to design overhangs with more safety than was possible with single rear-wheel axles—with only a slightly harder ride resulting.

Backpack tent anchor



Now there's a mini version of the unique Anker stake, designed for small backpacked tents. It weighs only .62 ounce but anchors tents up to four-man size. It's made by Pathfinder, P.O. Box 730, Oakville, Ont. 00102.

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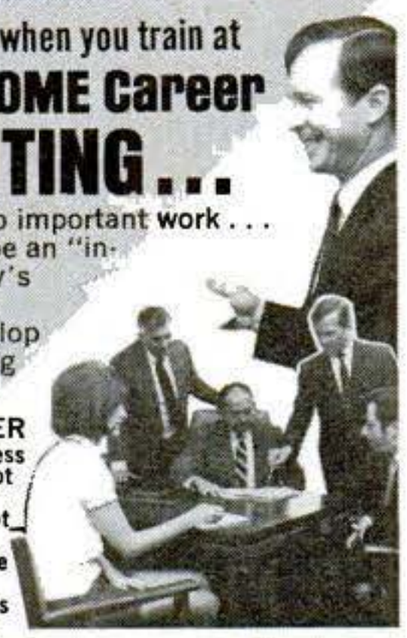

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A Chain-Reaction Burglar Alarm— Its Bark Is Worse Than Its Bite

By ERNST BEHRENDT

Any owner of a dog and a tape recorder can rig up a burglar alarm complete with a self-powered amplifier system. This is how I did it:

First, I tape-recorded my Scottish terrier Marcus as he barked at a squirrel stealing sunflower seed from a bird feeder. (A German shepherd barking at a raccoon will do.) In the evening, I placed the playback with the tape on it inside an ash can, which lay on its side behind bushes near the beginning of my driveway; the ash can was to protect the set from moisture. I then plugged the playback into an outdoor outlet, turning the volume control all the way up. Finally, I tied a nylon fishing line to the starter switch, stringing the line across the driveway about a foot above the ground and attaching it to a tree on the other side.

The theory was that any prowler walking or driving along the driveway at night would set off a ferocious prerecorded bark inside an invisible ash can. In practice, it was even better.

Three weeks after its installation, the ash can bark started up in the middle of the night. Marcus may have been the first Scottie in history to hear his own voice coming full blast from a bush 300 feet away; at any rate, he immediately began accompanying himself. Seconds later, the booming bass of the live black Newfoundland across the road came through with alarming clarity and volume, arousing the two brown mongrels next door—ugly beasts with raucous voices. The next dog to be heard from was a well-known fox terrier with a distinctively shrieking, hysterical yelp; but after that it was impossible to identify any of the 10 or 15 barks exploding furiously all over the neighborhood.

It is not everybody's (or everything's) inclination to remain calm after stepping into a kind of wasps' nest of angry canines yapping, snapping, howling, barking, and growling in the dead of night. If he (or it) ever identified the tape recording as such, he (or it) must have also been aware of the multitude of dogs willing to defend their master's property. The experience must be unnerving.

Suggestion: Replace the crude fishing-line triggering device with the kind of light beam that opens the door in a supermarket. It'll save you the trouble of putting the line down every evening and picking it up in the morning.

[*Editor's note:* Don't be too quick to take all of this lightly. As a matter of fact, it has come to our attention that there are companies that sell prerecorded howls, woofs, and barks for just this purpose.]

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John Deere's new 6¾-pound* chain saw.

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*Engine weight less guide bar.**Suggested U.S. list price, F.O.B. Park Forest, Ill. Slightly higher in Canada. Price subject to change without notice.

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POPULAR SCIENCE · CAR TEST · NORBYE/DUNNE REPORT

The '72 Small Cars: Lots of Improvements

By **JAN P. NORBYE** / *PS Automotive Editor* **and JIM DUNNE** / *PS Detroit Editor* PHOTOS BY A.J. HAND

When the '71 small cars from Detroit came out, both Ford and Chevolet announced that no big changes would be made in them for the next five years. Now, for 1972, we find a lot of improvements, but no senseless sheet-metal changes, no changes just for the sake of change.

We made 10,000-mile tests on all three domestic sub-compacts when they were new. We drove the low-price series, thinking that those would be the best-sellers. But the public surprised us (and Detroit) by ordering deluxe and power options that pushed the average price way outside the economy-car field, as we then defined it. This year, we tested the top-line models, with price tags in the $2,700 to $3,000 range.

These are proving the most popular, and due to the import surcharge and the price increases on European and Japanese economy cars, the Pinto, Vega, and

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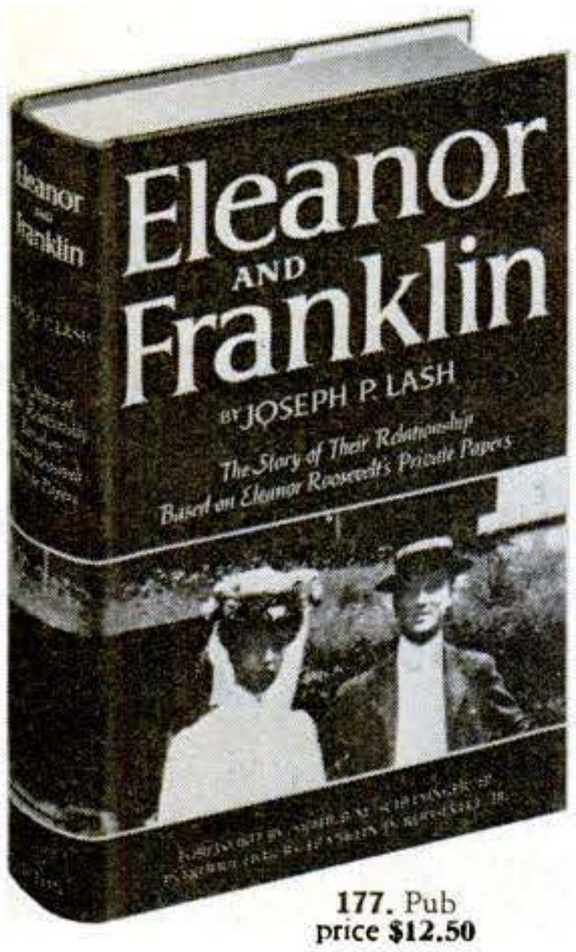

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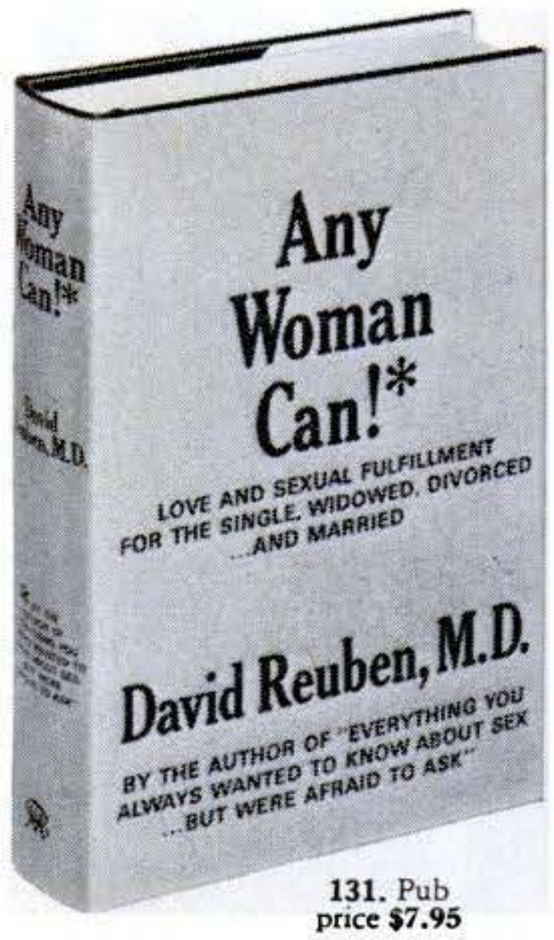

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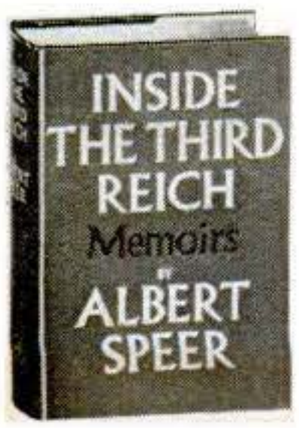

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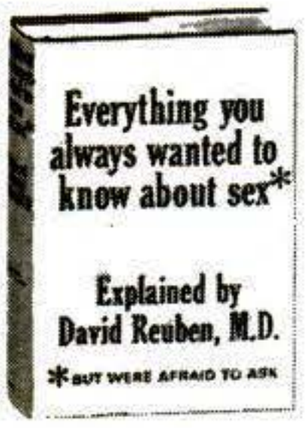

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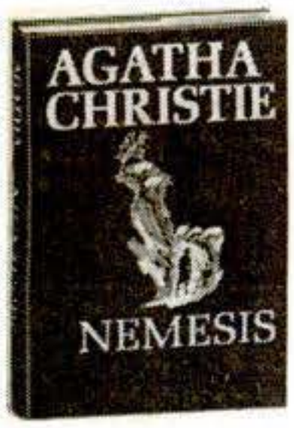

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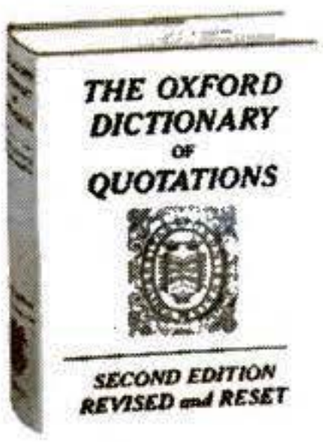

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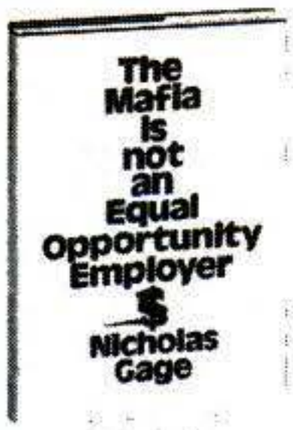

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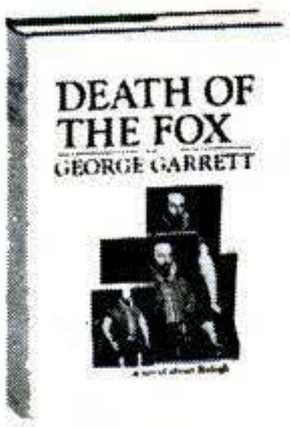

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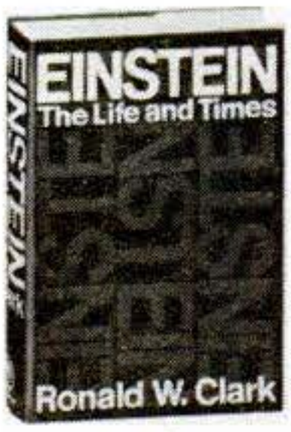

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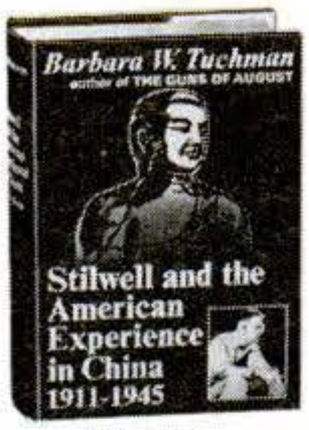

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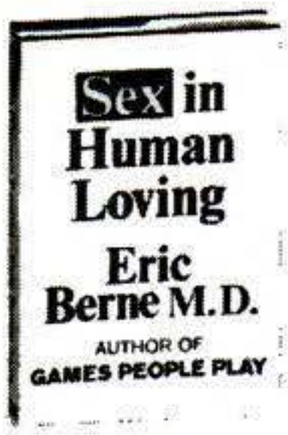

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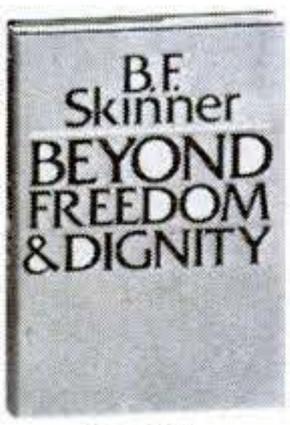

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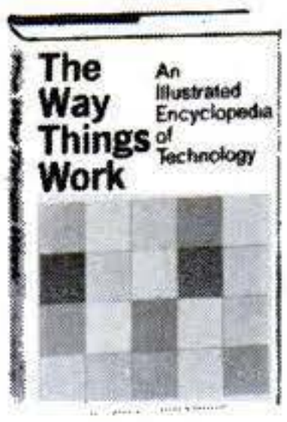

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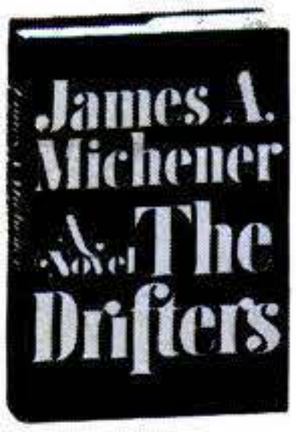

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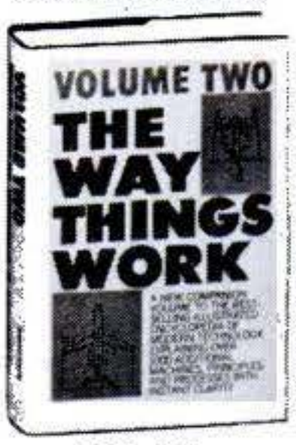

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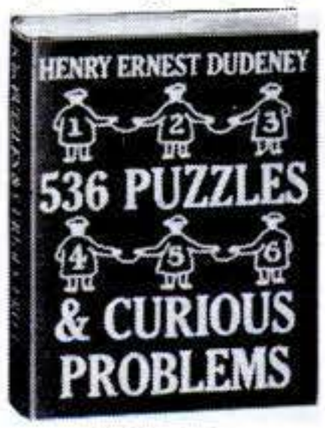

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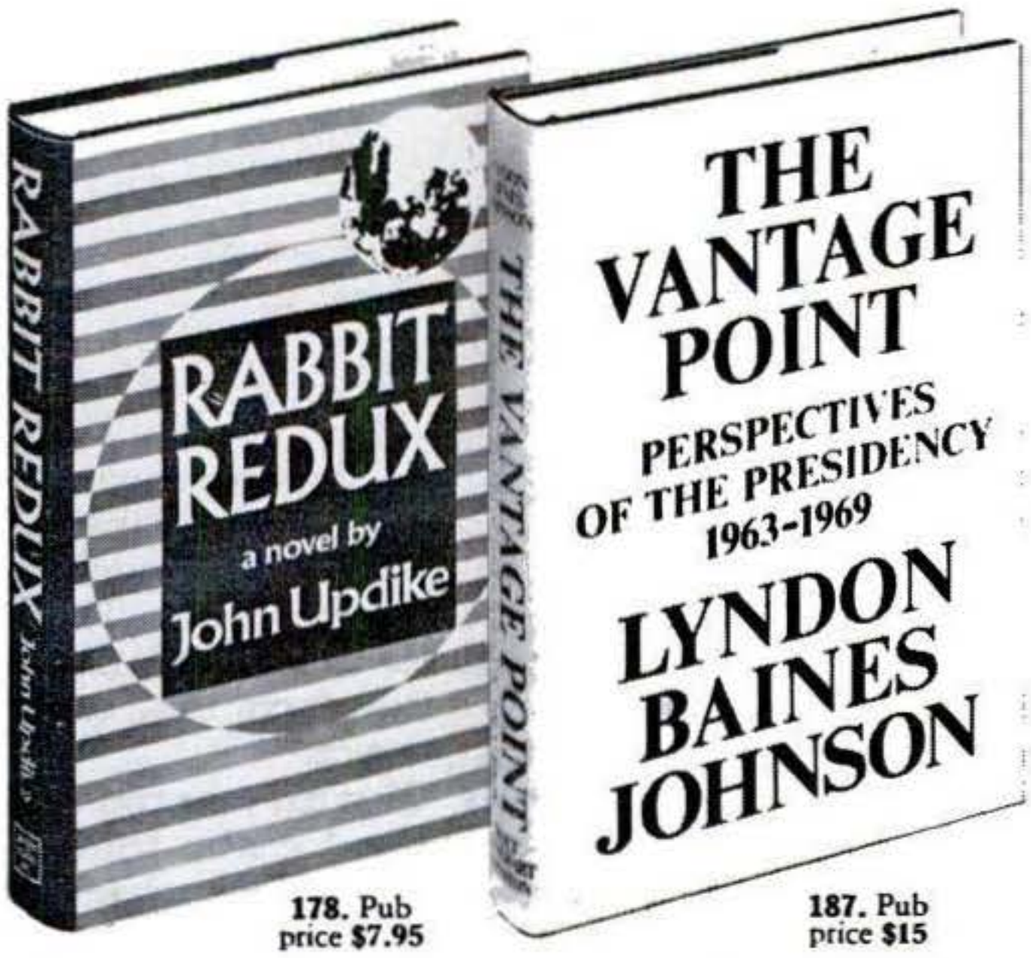

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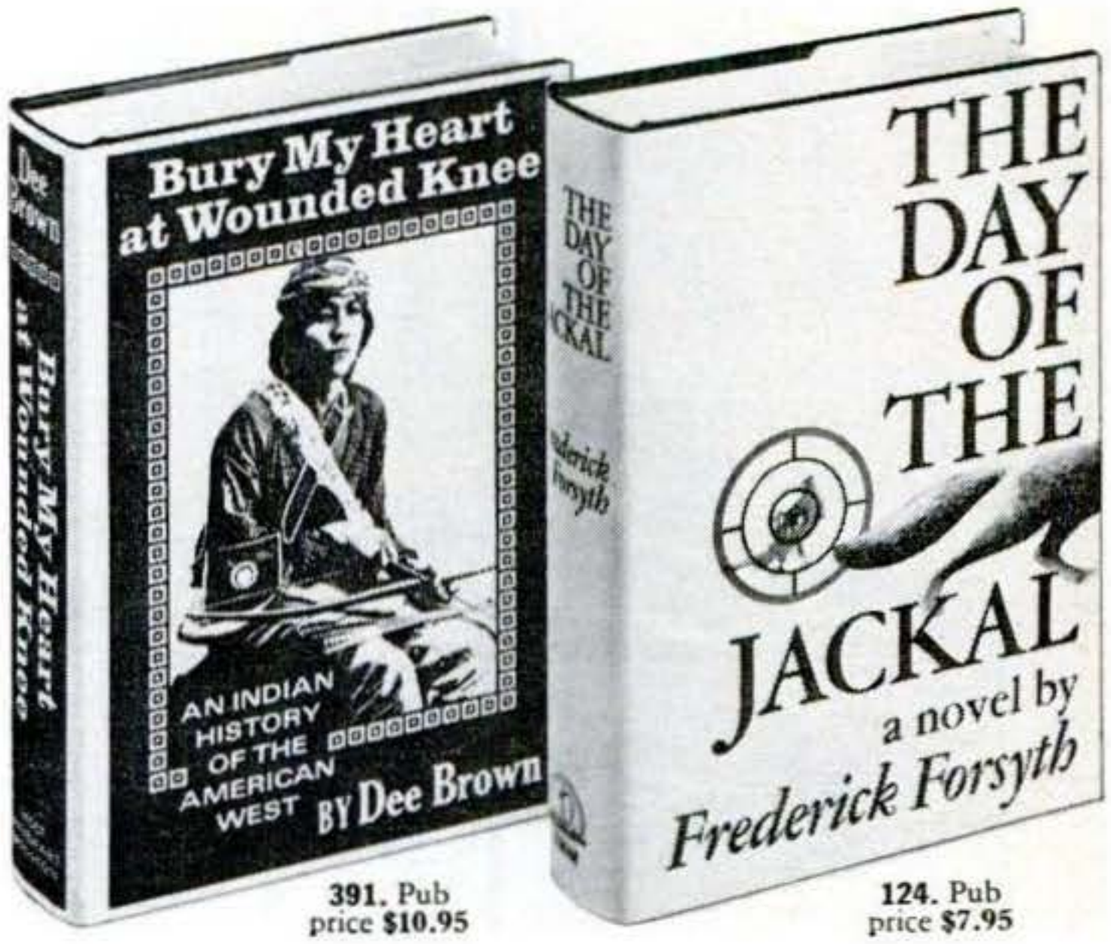

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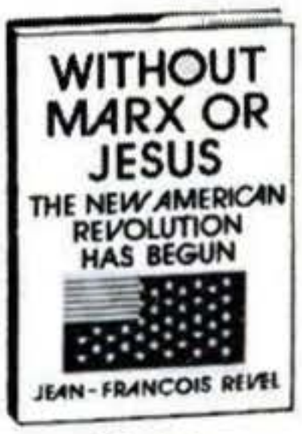

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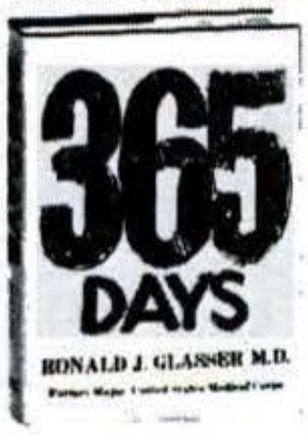

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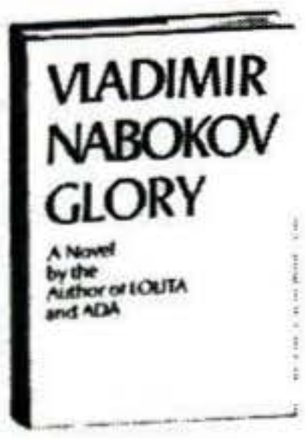

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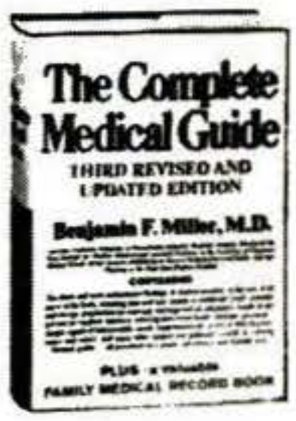

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The Gremlin X (top photo) with its wide tires was able to equal the speed of the Vega (center) in the lane-change test. The Pinto (bottom) with initial understeer and increasing roll oversteer, was the fastest, despite its small tires.

Gremlin must be considered not only price-competitive but excellent value. Our report will tell you why. First, consider a few facts:

All are two-door subcompacts. The Vega and Pinto are four-seaters; the Gremlin seats only two adults. The Pinto and Vega have small four-cylinder engines of modern design, with overhead camshafts. The Gremlin has the standard six from the Hornet. The small engines have to work harder (and are noisier) because they are unable to pull the same low axle ratio as the American Motors six. The Pinto and Vega were created by the same philosophy that guides auto engineers in Europe and Japan. The Gremlin is a hybrid, sharing a maximum of body parts and drive-train components with existing models. Which is the better approach? The test results speak for themselves, and there are many other facts that can help you reach a decision.

Chevrolet Vega. This car now comes with a three-speed automatic transmission that overcomes the drawbacks of the two-speed Powerglide used in '71. Performance is good, fuel economy disappointing. Front disk brakes are standard, and the car did well in our brake tests (except for a tendency to lock rear wheels).

Ride and handling? The steering is a little vague near dead center but response is satisfactory. Ride comfort is surprisingly good on straight roads, but on winding roads the Vega is subject to sudden sideways rocking motions (sometimes accompanied by a sideways axle movement). It's not at all unsafe—just disagreeable. At lower speeds (and lower lateral g-loads) the phenomenon does not occur.

Vega has the most civilized interior Plastic door panels look neat and are easy on your knees. Cranks and han-

Continued

Gremlin X broke all records for short stopping distance with cool brakes.

Vega suffered partial rear-wheel locking and lost stability during brake test.

Pinto, with regular tires, stopped in amazingly short distance, without any sign of wheel-locking, front or rear. Retardation easily exceeded 1.0 g.

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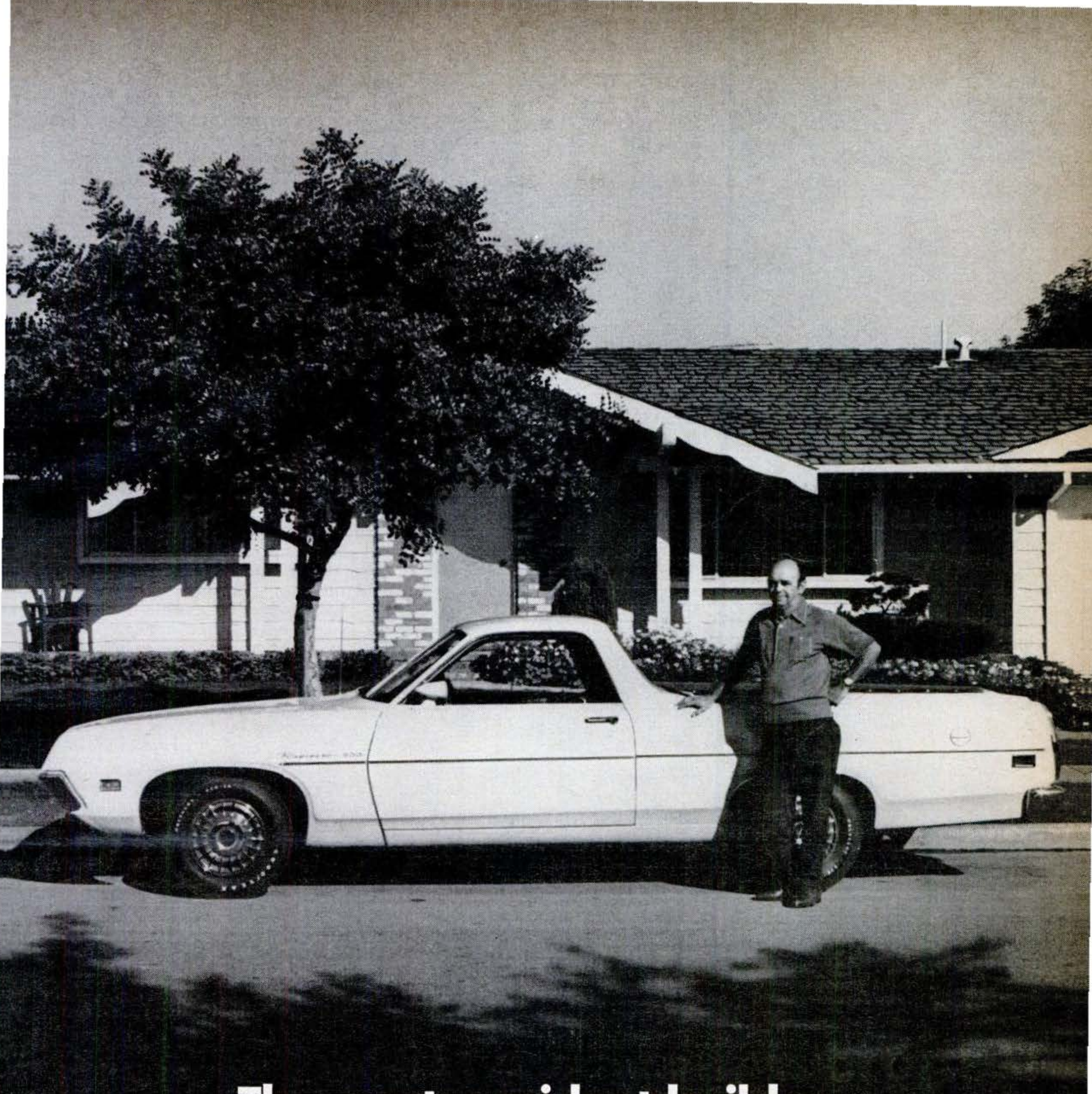

The master midget builder.

For 35 years Leonard Gonsalves has been building racing machinery.

"When I got out of school, somebody sold me a bandsaw for $7.00. So I built a racing boat. It went real well, so I built some more and sold them.

"Then I started building midget race cars. I guess that's what I always wanted to do. I've got a real beauty down at the shop now. It'll be the fastest one I've ever seen.

"I bought the Ford Ranchero to take my racers to the track. And I switched it over to Champions first chance I got. Well, you know, I've always raced with Champions and I guess I know what's best for an engine."

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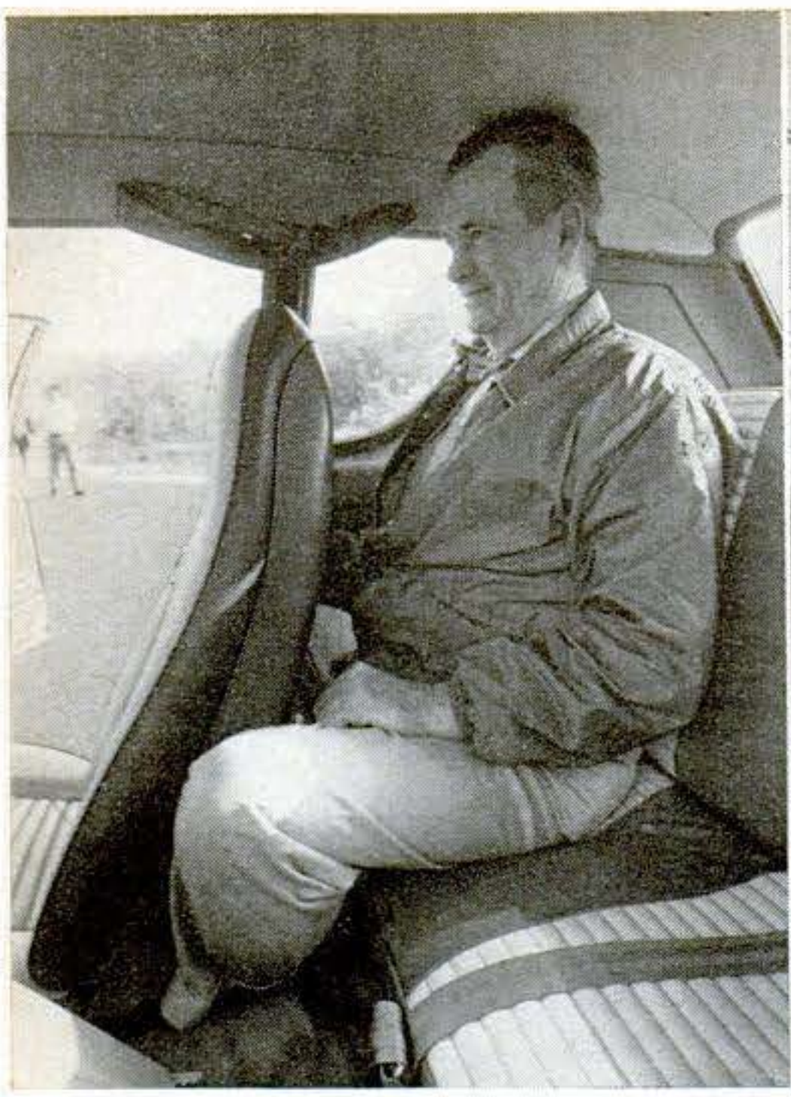
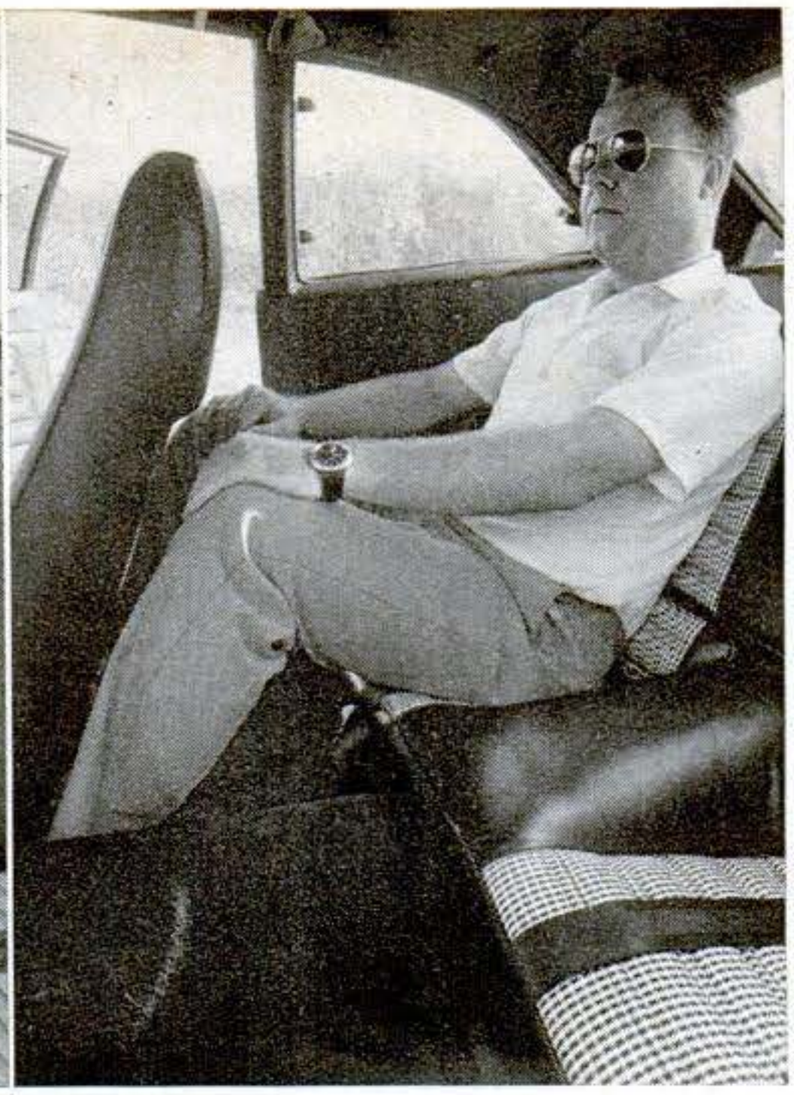


Back seat of Gremlin does not meet the minimum space requirements for adults.

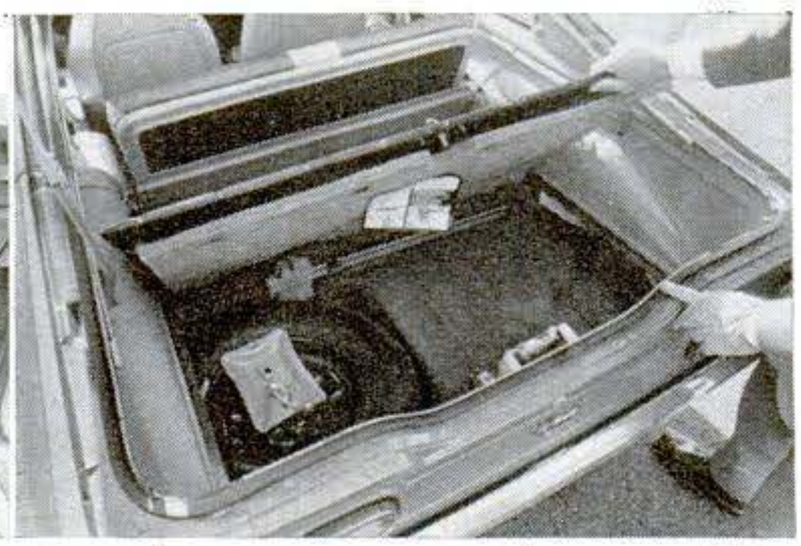


Back seat of Pinto is low, but offers reasonable head, knee, and legroom.

Pinto has high-level vents in instrument panel, T-handle transmission stick on floor tunnel, and pull-up hand brake.

Pinto's rear door has low liftover height. Back seat folds up, and spare tire is housed under cargo-area carpeting.

Vega steering wheel has new design; glove box is added for '72. Shown here is the custom (optional) instrument panel.



Vega has a compartment that's small but lockable under trunk floor (next to the spare wheel). Liftover is fairly high.

Gremlin X steering wheel is sports type. There's a pedal-operated parking brake; wide tray under instrument panel.

Gremlin X has no rear door, and liftover height is uncomfortably high. Rear seat folds down for bigger cargo area.

dles are well placed, and the pocket in the driver's door is handy. Seats are much improved, and the exhaust note is quieter. The rear-axle hop during hard braking that afflicted the '71 model has been eliminated. The cowl air intakes on both sides have been retained.

Vega does not offer a wide brake pedal for cars with automatic transmission. The coupe needs a rear-window defroster (not offered). An interior hood lock is standard. Pull-up parking brake on floor tunnel works very well. Simple one-side release for rear seat back allows easy folding to get longer load platform. The rear window frame is really a third door for cargo loading.

Ford Pinto Runabout. This half-sedan half-wagon is the roomiest domestic subcompact. Performance is acceptable, fuel economy disappointing. Pinto scores on ease of driving. The rack-and-pinion steering is free of kickback and vibrations, but offers no extra precision over recirculating-ball steering gears on other Fords.

The ride is not so well cushioned as in the Vega, but the car proved faster in the handling tests. Firm understeer is gradually modified by roll oversteer as cornering speeds and lateral g-load increase. The Pinto is fully predictable in its behavior right up to the limit, and is free of quirks. With the optional front disk brakes, the car has an outstanding brake system with uncommonly good front/rear balance as well as first-rate stopping power.

Controls and instruments are well placed, but instrumentation sparse

Continued

NOISE-LEVEL TESTS

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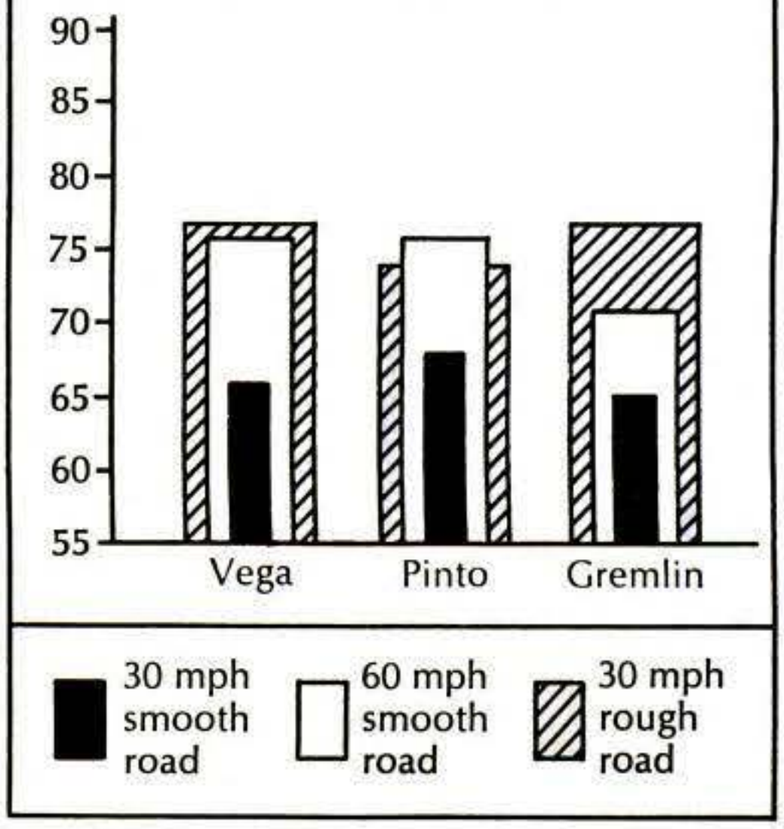

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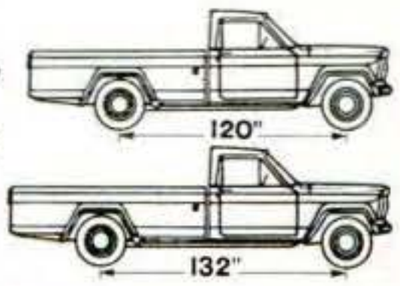

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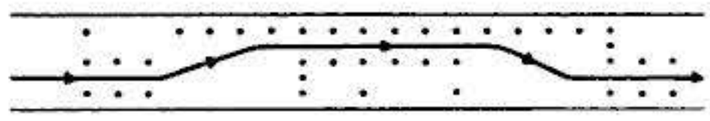
How other cars have fared in our tests

CAR	1971 VEGA	1971 PINTO	1971 GREMLIN	DATSUN 1200	DATSUN 510	DODGE COLT	FIAT 128	FIAT 124-S	PLYMOUTH CRICKET	VOLKSWAGEN SUPER-BEETLE	TOYOTA COROLLA	TOYOTA CORONA
Accel. 0-60	20.1	17.8	19.2	18.4	16.2	14.2	19.9	15.4	22.2	19.5	18.6	16.6
Accel. 0-80	41.0	36.6	33.5	37.0	32.6	27.2	39.2	31.3	—	44.0	37.8	31.9
Accel. 25-70	21.4	18.8	21.8	21.0	16.8	15.8	23.6	17.5	30.4	27.3	22.0	17.6
Brakes 60-0	163.3	153.0	218.2	159.3	225.9	152.5	134.9	150.6	150.6	126.6	167.7	166.8
Lane change	53.0	53.8	54.6	53.0	53.0	60.0	62.4	59.5	56.3	58.2	49.8	49.8
Slalom	26.3	25.6	24.8	26.6	26.0	27.6	30.1	26.7	27.2	27.6	24.2	24.7
Fuel (mpg)	20.9	19.7	20.7	36.6	33.0	28.5	37.5	34.2	24.3	30.1	35.3	27.7
Noise (60 mph)	83 dbA	78 dbA	77 dbA	79 dbA	77 dbA	76 dbA	76 dbA	79 dbA	80 dbA	77 dbA	77 dbA	76 dbA
Price	$2,445	$2,508	$2,433	$1,736	$2,035	$2,385	$1,795	$2,065	$1,915	$2,049	$1,798	$2,225

How PS tests cars—and what the tests show

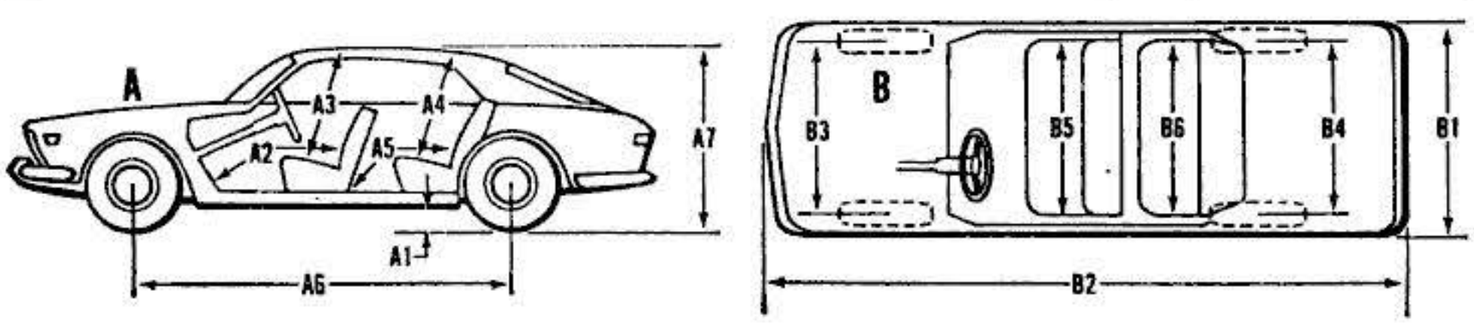
Brake test shows a car's ability to stop from 60 mph without wheel locking. Test is first made with cool brakes, then repeated after 10 warmup stops from 60 at one-minute intervals with 0.5g deceleration. First test shows braking capacity, balance; the second, fade. Excessive pedal pressure indicates fade. Excessive distance indicates fade, incipient or partial locking, or combination of both.

Acceleration test at 0-60 mph shows a car's ability to reach cruising speed from standstill. The 0-80 mph test shows its high-speed power reserve; 25-70 mph test simulates a highway merging situation. Cars with automatic transmission are tested in DRIVE.



Two lane changes in quick succession show a car's ability to make an emergency maneuver at speed. Lanes are blocked 120 feet apart, and lane-change gaps are 60 feet long. Each car is put through test at increasing speed until its maximum is established.

Low-speed emergency maneuver test means snaking a car as fast as possible through pylons 48 feet apart. In both handling tests, times clocked by two stopwatches are converted to mph.



	CHEVROLET Vega	FORD Pinto	GREMLIN X
DIMENSIONS (inches)			
A1 Ground clearance	4.8	4.8	5.0
A2 Front leg room (max.)	42.8	41.7	41.05
A3 Front head room	37.6	37.8	38.0
A4 Rear head room	36.6	36.3	36.4
A5 Rear leg room (min.)	30.8	31.4	29.0
A6 Wheelbase	97.0	94.2	96.0
A7 Height	50.0	50.1	51.8
B1 Width	65.4	69.4	70.6
B2 Length	169.7	163.0	161.25
B3 Front track	55.1	55.0	57.5
B4 Rear track	54.1	55.0	57.0
B5 Front hip room	49.4	51.8	54.9
B6 Rear hip room	42.5	44.3	53.0
SPECIFICATIONS			
Engine type	SOHC 4-in-line	SOHC 4-in-line	OHV 6-in-line
Displacement (cu.in./cc)	140/2,292	122/1,995	232/3,802
Compression ratio	8.0:1	8.0:1	8.0:1
Carburetion	One 2-bbl.	One 2-bbl.	One 1-bbl.
Net hp @ rpm	90 @ 4,800	86 @ 5,400	100 @ 3,600
Net torque @ rpm	121 @ 2,800-3,200	103 @ 3,200	185 @ 1,800
Transmission	3-speed auto.	3-speed auto.	3-speed auto.
Axle ratio	3.36:1	3.55:1	2.73:1
Tire make	General G	Firestone	Goodyear
Tire type	Belted Jumbo	Deluxe Champion	Polyglas
Tire size	A78-13	A78-13	D70-14
Turning diameter	33 ft.	31.5 ft.	32.75 ft.
Turns, lock to lock	4.4	4.16	3.3
Brakes	Disk/drum	Disk/drum	Disk/drum
Fuel tank (gal.)	11.0	11.0	21.0
Trunk space (cu. ft.)	9.3	6.1	6.0
Liftover height (in.)	31.2	27.2	33.9
Curb weight (lbs.)	2,451	2,316	2,621
TEST RESULTS			
Acceleration 0-60 mph	15.7	16.8	14.7
Acceleration 0-80 mph	31.8	36.1	31.5
Acceleration 25-70 mph	19.4	20.8	17.2
Braking distance (cool) 60-0 mph	135 ft. 9 in.	109 ft. 5 in.	108 ft. 2 in.
Pedal pressure	130 lbs.	115 lbs.	80 lbs.
Braking distance (hot) 60-0 mph	143 ft.	132 ft. 10 in.	134 ft. 5 in.
Pedal pressure	155 lbs.	130 lbs.	140 lbs.
Max. speed—lane change	60 mph	61.2 mph	60 mph
Max. speed—slalom	26.8 mph	27.6 mph	26.8 mph
Gas mileage (constant 45 mph)	21.075 mpg	21.043 mpg	21.511 mpg
Price (basic)	$2,070	$2,137	$2,040
Price (as tested)	$2,703	$2,966	$2,940

(speedometer and fuel gauge only). Front seats are low (for adequate head room), adversely affecting comfort and visibility. High-back bucket seats and wide C-posts also interfere with side and rear views. Rear seating dimensions are surprisingly ample, and doors open wide for easy access. The Runabout has heating wires in the rear window for defrosting, but lacks an interior hood lock.

Gremlin X by American Motors. The X has a heavy six-cylinder engine that assures stability in crosswinds. It is the heaviest car in the group (since the front two-thirds is a duplicate of the compact Hornet). On smooth roads, it has more of a big-car ride than the Pinto and Vega, and has superior power and performance. All braking and handling problems of the '71 Gremlin have been rectified. No more roll oversteer; no more rear-wheel locking. The X is a better balanced car. On rough roads however, the ride is hard and choppy.

Instrumentation is unpretentious, but gauges are easily read. Column-mounted transmission lever liberates floor tunnel, and parking brake is foot-operated. Inside hood release is standard. Seating comfort is hampered by excessively long steering column, which puts the wheel too close to the seat back (and too far from dash). Rear seat room is usable only for children. Cargo area is less accessible than in Pinto and Vega, but rear seat back folds easily.

The quick-ratio manual steering is recommended for men; it may call for more muscle at low speeds than most ladies will be happy about. Power steering is optional (and recommended over the standard slow-ratio manual steering).

The power-assisted front disk brakes, in combination with the wide-section tires, gave extremely short stopping distances. The Gremlin X now holds the overall record for short stopping (with cool brakes), with the Pinto a close second.

The automatic transmission in the '72 Gremlin, built by Chrysler, corresponds closely to the TorqueFlite in Chrysler Corp. cars. Shifts are far more positive than in the Borg-Warner transmission formerly used by AM. In return, shifts are not as silky smooth, but not objectionable.

Conclusions

Norbye: I choose the Pinto, mainly for its brakes, ride, and handling, though for better performance I'd get the standard four-speed manual gearbox instead of the automatic.

Dunne: I'll go with the Vega. It's a more refined automobile, every bit as practical as the Pinto for a family man, and superior to many imports in performance and safety. PS

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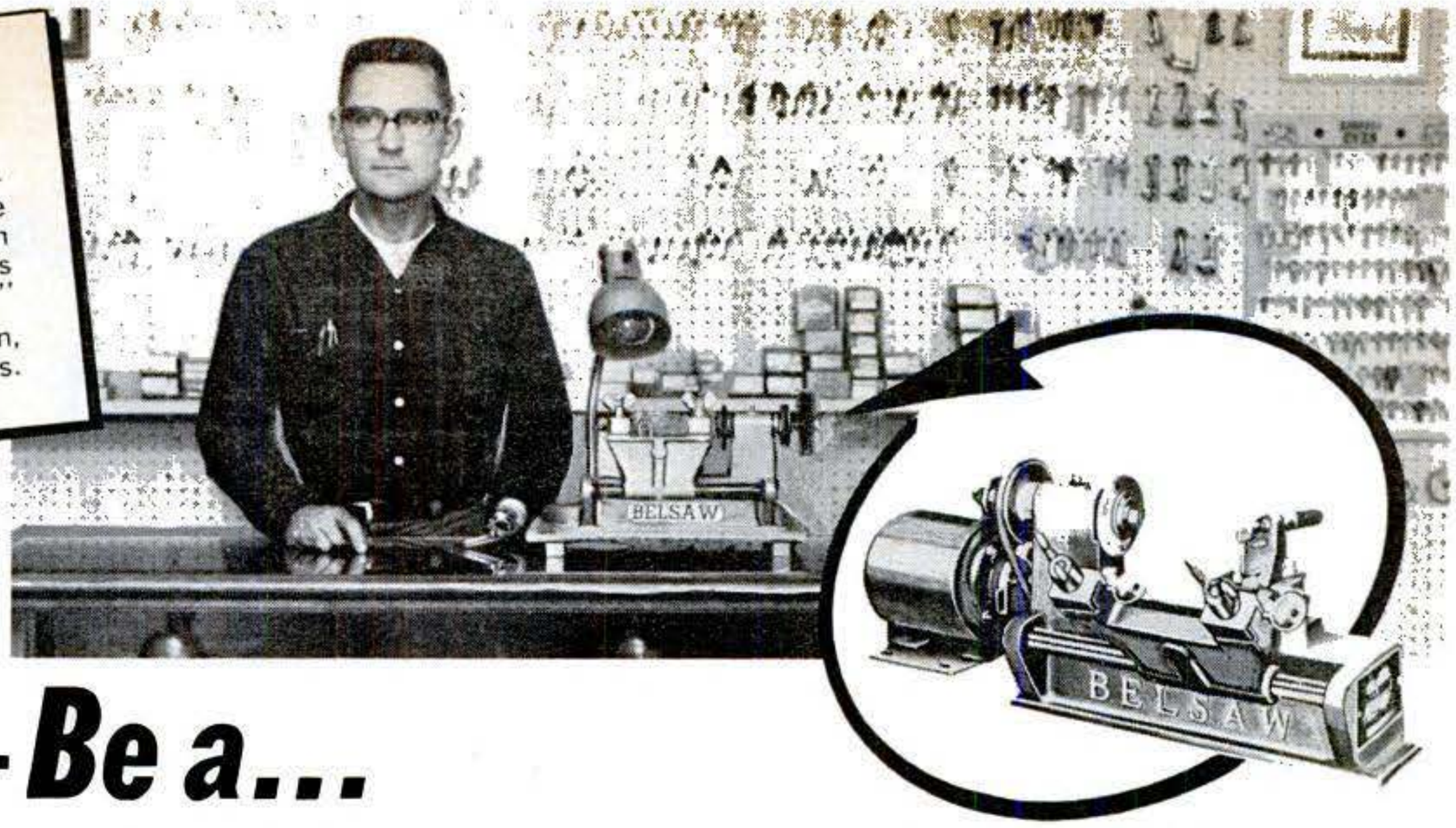
says Glen Johnson, Larned, Kansas.



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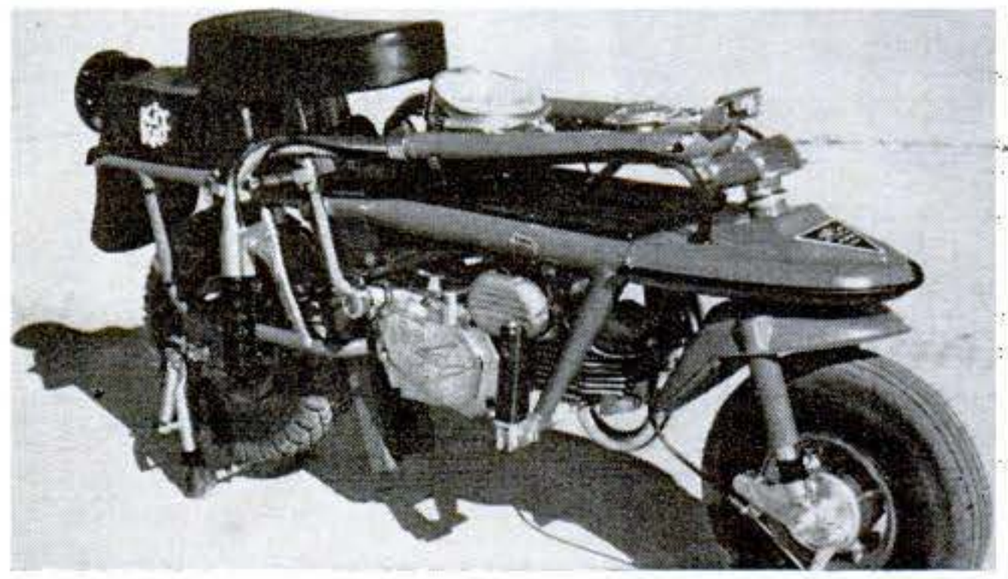
PERSONAL-USE REPORT

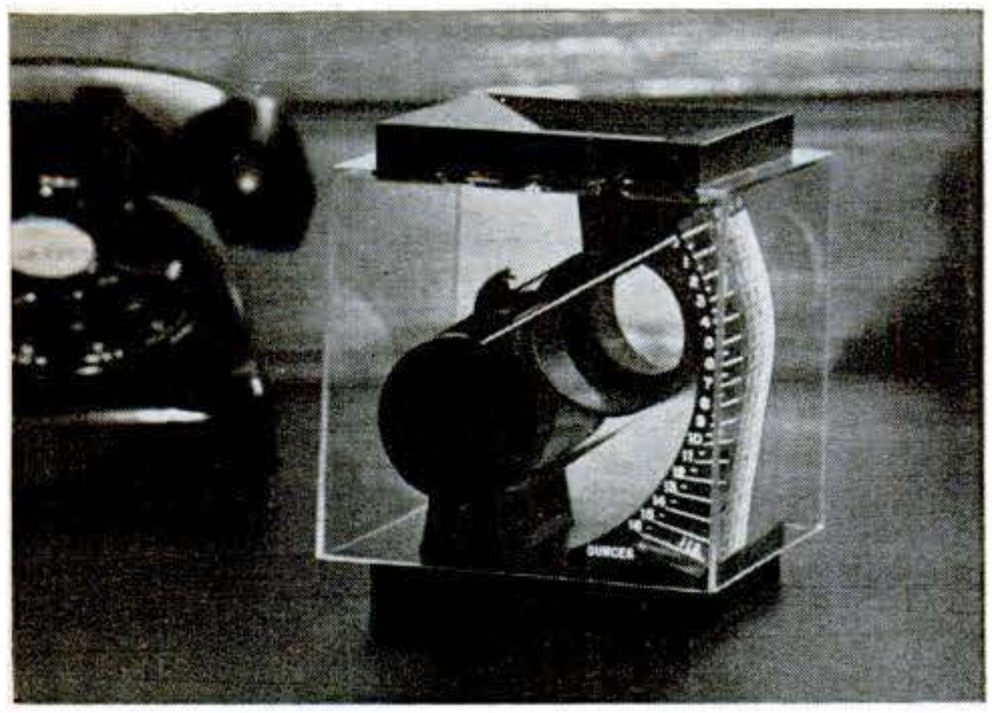
Fold-Up Mini You Carry in a Case

One problem in boating, flying, and other forms of recreational travel is how to get around when you get there. One solution is Kit Kat, a folding mini from Italjet. The little 73-pound machine fits easily in small cars, planes, and boats. Powered by a 49cc, 2.2-hp, two-stroke engine, the Kit Kat has a single-speed transmission with an automatic centrifugal clutch. The bike can't be licensed for street use, but it can save you a lot of shoe leather around a mobile-home park, airport, or marina. Price: around $315. Speed Center, 825 S. Victory Blvd., Burbank, Calif. 91502.—*Jim Davis*

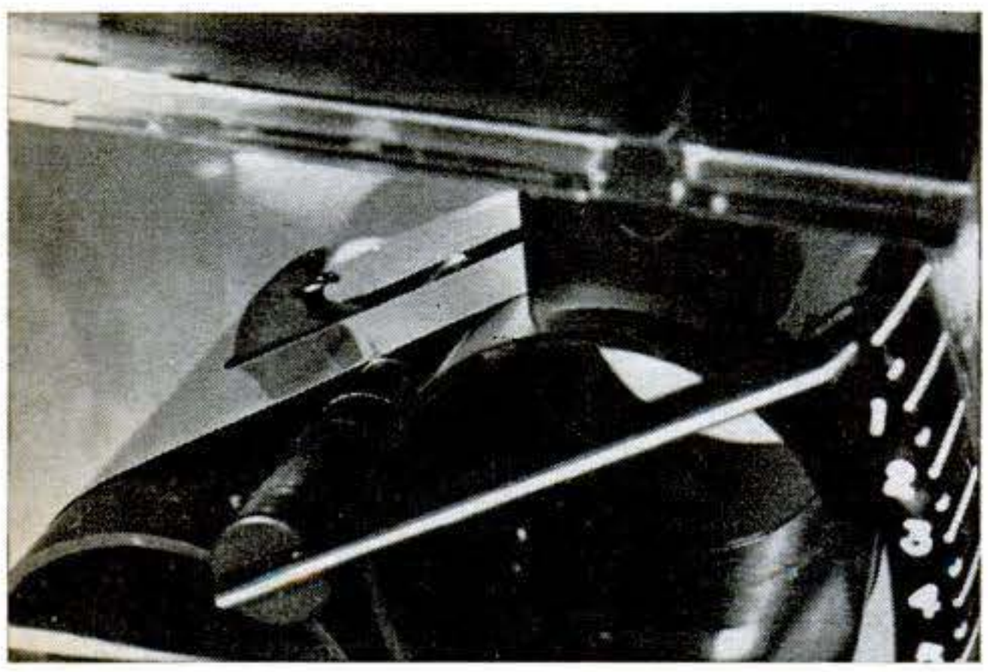
Easy to carry, the Kit Kat fits easily in a small plane, boat, or camper. A protective vinyl carrying case is optional.



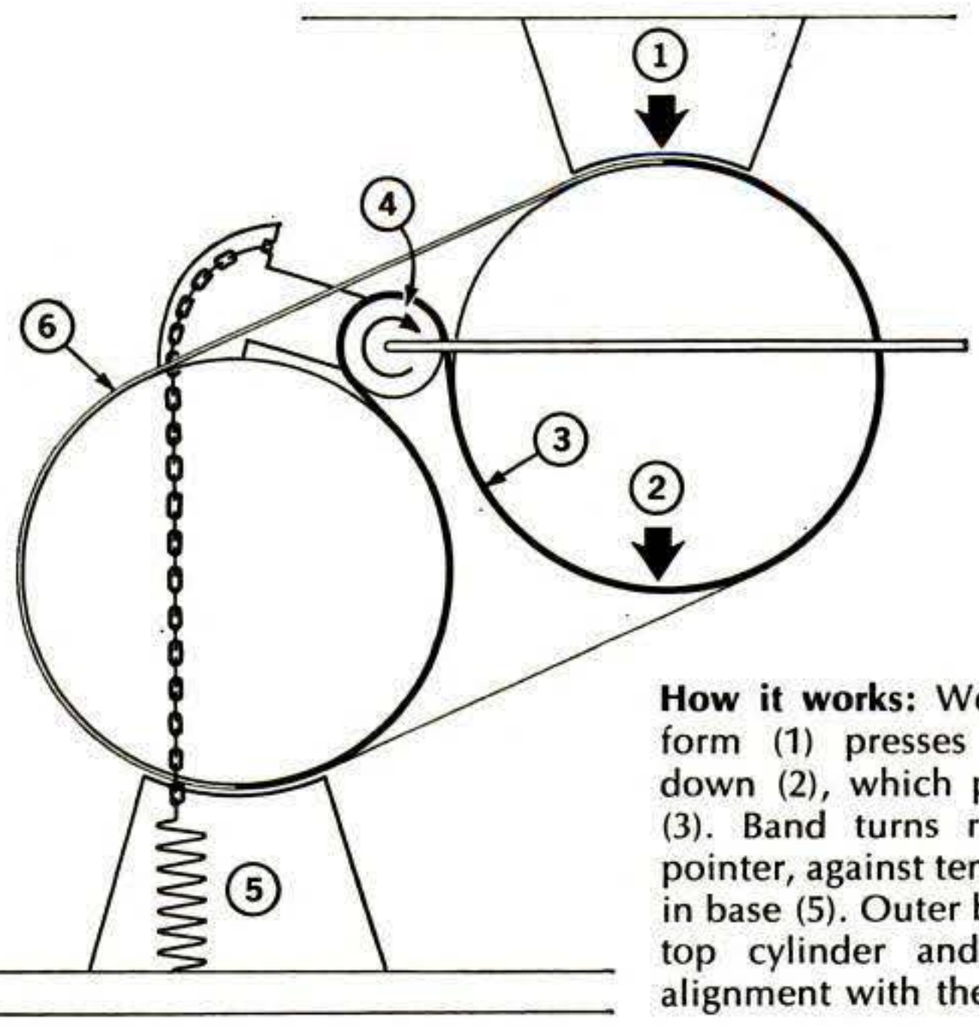
For transport, three-position seat slides down to the frame. Handlebars fold down. Make-ready time is only a few seconds.



Plastic Rolamite scale is designed for letters, but dished platform can accommodate other objects, too.



Small roller, snugged against cylinders by inner band, turns against spring tension to move scale pointer.



How it works: Weight on platform (1) presses top cylinder down (2), which pulls on band (3). Band turns roller (4) and pointer, against tension of spring in base (5). Outer band (6) holds top cylinder and platform in alignment with the base.

Turning Roller Tells the Weight

A free-turning roller, held in place only by a flexible band, turns a pointer to tell the weight in this new scale. The design is based on the Rolamite principle [PS, Mar. '68] for frictionless movement using two rollers and a flexible band. Strictly, the Rolamite scale is not a Rolamite, but its design springs from experience in working on Rolamite band-and-roller elements. The sleek black scale is priced at $12.50, and is made by Rolamite, Inc., 260 California St., San Francisco 94111. In tests by PS, it proved quite accurate.—*Everett H. Ortner*

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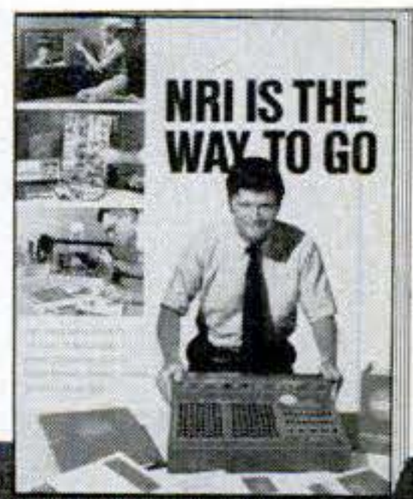

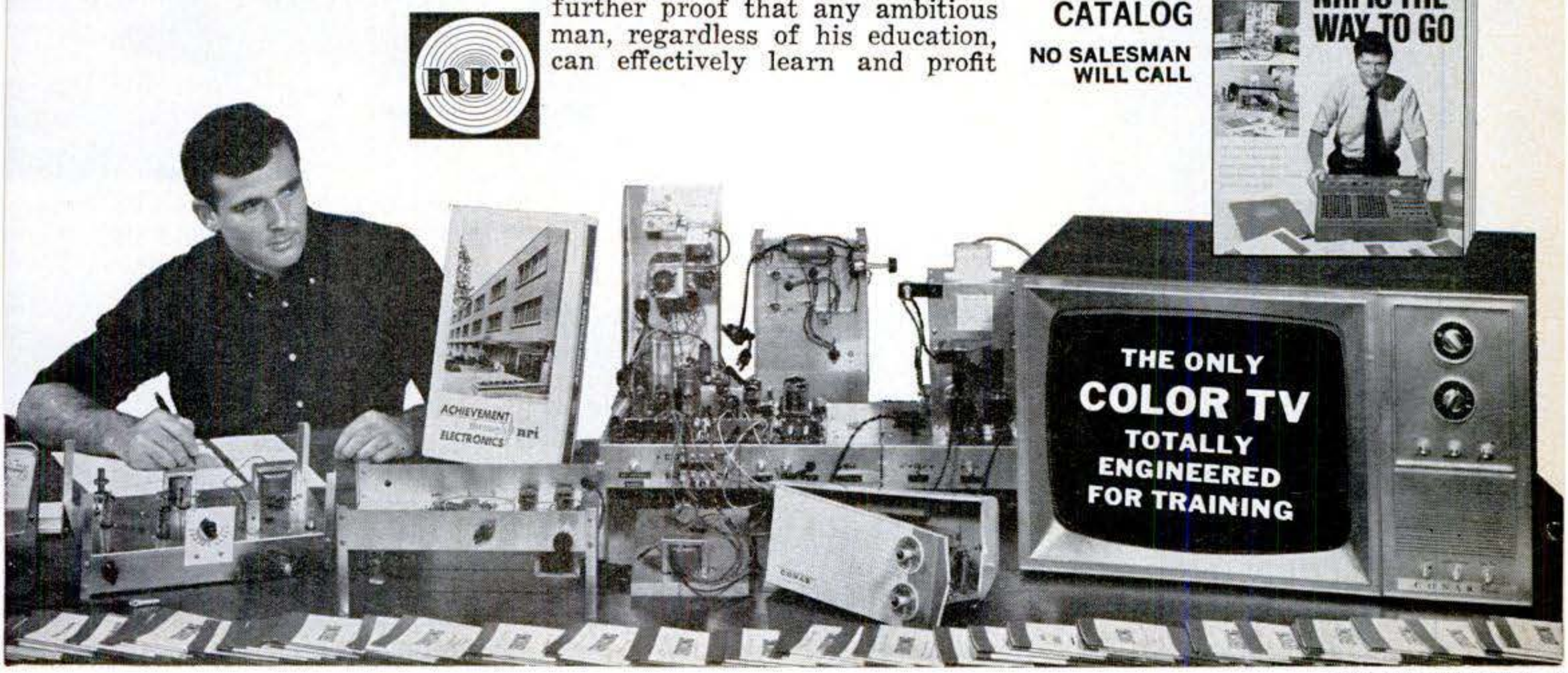

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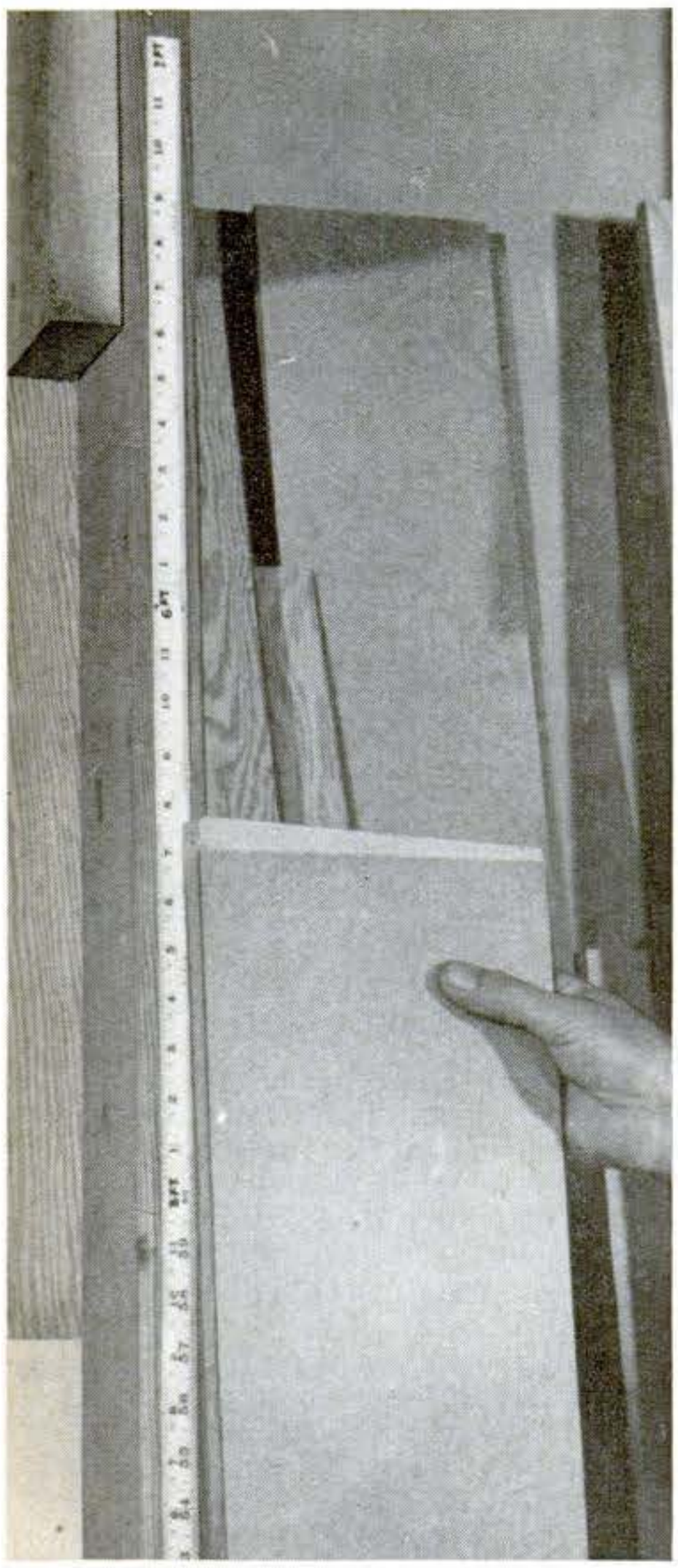
Anywhere You Need a Measuring Tape— Just Stick This One On



Check the length of those large pieces? It's easy this way. Two cutoffs were combined here to make a seven-foot gauge.

Whether you're replacing worn-out scales or inventing new ones, this idea will save time and trouble

By R. J. De CRISTOFORO

A measuring tape anywhere? That's right, with this new adhesive-backed tape from Disston.

Uses? Renewal, for one thing. You might stick one on a table-saw rip-fence gauge that has seen better days, or on the depth gauge of a drill press. And it's not out of line to consider them for new tools. Since the tapes are pretty accurate (.004-in. tolerance), they might do a better job than permanent scales on some equipment.

I tried a piece on my rip fence as a blade-projection gauge. But if the work must be firmly in contact with the fence, the tape—thin as it is (.005 in.)—creates pass interference. The rip fence will work, though, if you provide the plus amount between the fence and the "back" teeth of the blade, common on professional setups.

Of course you can use pieces on the *front* edge of almost any table (band-saw, jigsaw, table saw) without causing problems.

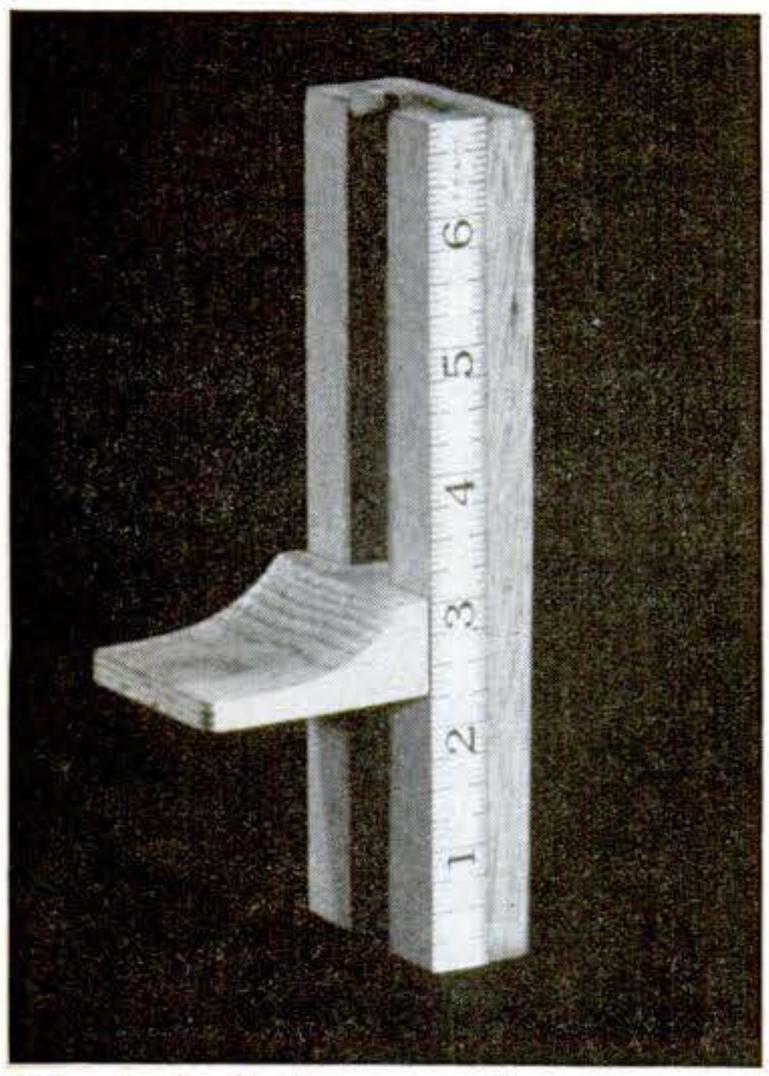
A length on a workbench surface or on a wall or stud near a wood rack can be very useful, too.

The tapes are good on accessories you make or buy. The blade-projection jig shown is one example. You can also use pieces on miter-gauge extensions, radial-arm fences and tables, and extensions for a table saw.

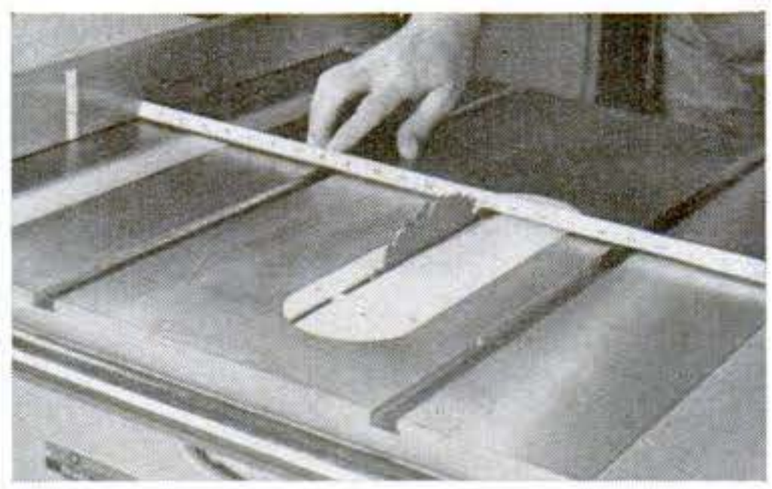
Since the tapes are quite flexible, and are not coved like encased versions, they are better for measuring circumferences (V-belt and pulley lengths, for example). Stick them to a slim, rigid stick in whatever length you need. A two- or three-foot length makes a better gauge than a conventional tape or folding rule.

Uses for the tape are not limited to your shop. A long strip on the wall of your den will easily measure your kids' height. And your wife may want to use a piece on her sewing-machine table or full-length mirror for quick hemline adjustments.

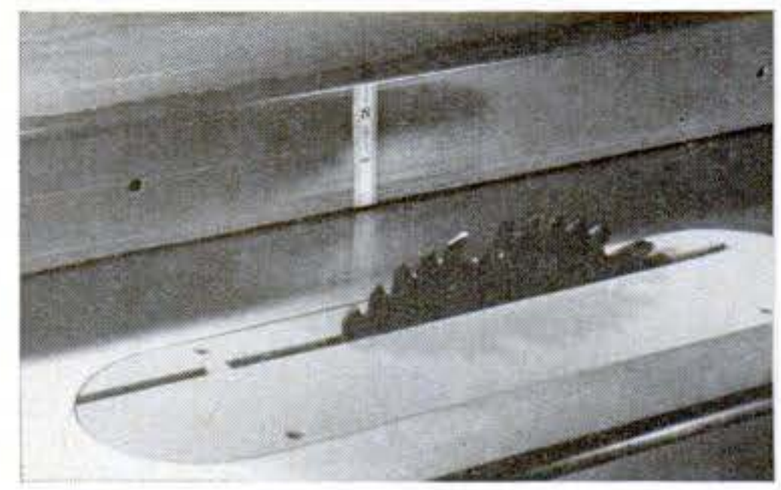
What do you do when you need only a small piece of the stuff? You can stick down the measuring tape to the last inch. Just block out cumulative calibrations and re-mark the foot indications by using self-adhesive blank labels, available in any stationery store. The tapes sell for $1.95 (½ in. wide by six ft. long) and $2.79 (¾ in. by 12 ft.) PS



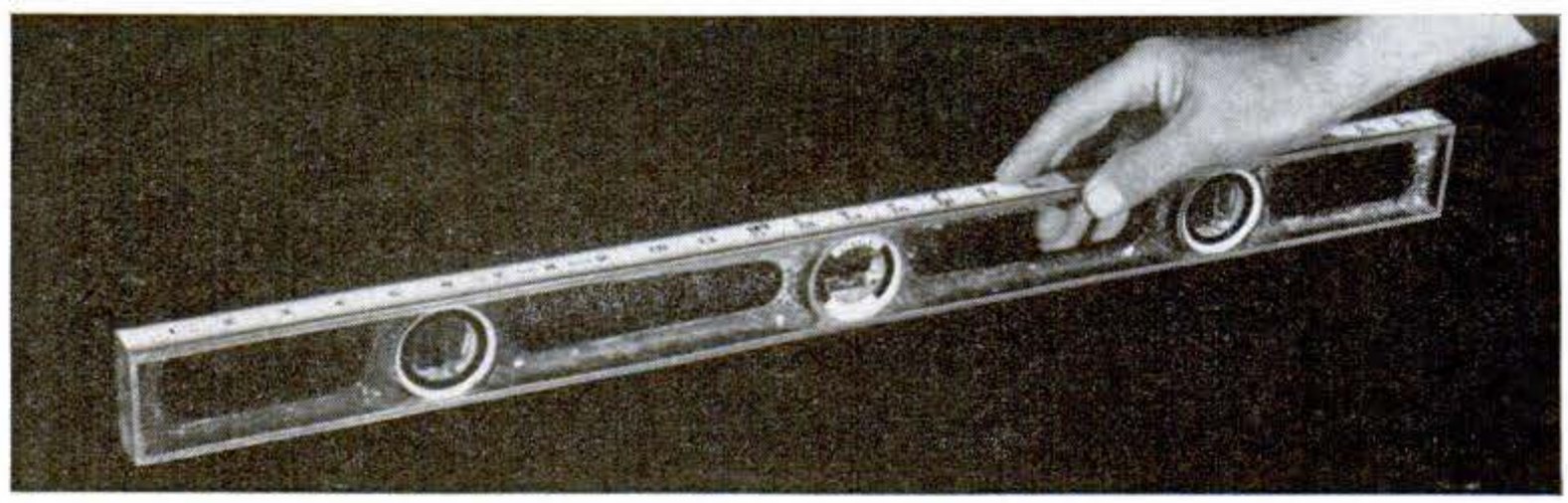
Adhesive-backed tape makes measuring more accurate. This blade-projection jig originally had a paper do-it-yourself scale.



Two- or three-foot length on a stick quickly measures fence settings. Longer lengths won't sag as steel tapes do.



A 2½-inch strip mounted on the fence becomes a blade-projection gauge. Be sure to allow for gap between fence and table.



You can use the tape on a level, as above, or on lathes, paper cutters, drawing boards.

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New Ideas from the Inventors

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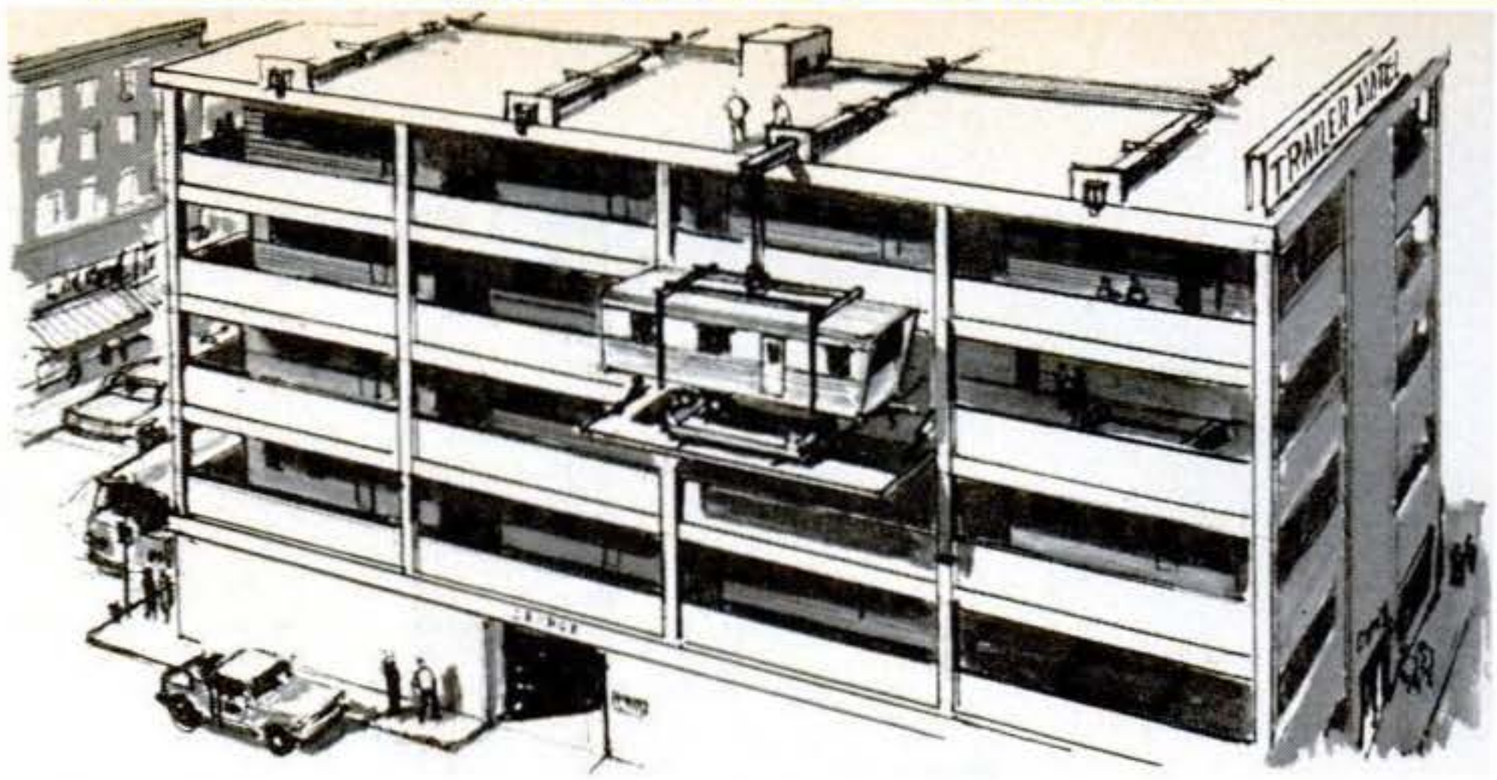
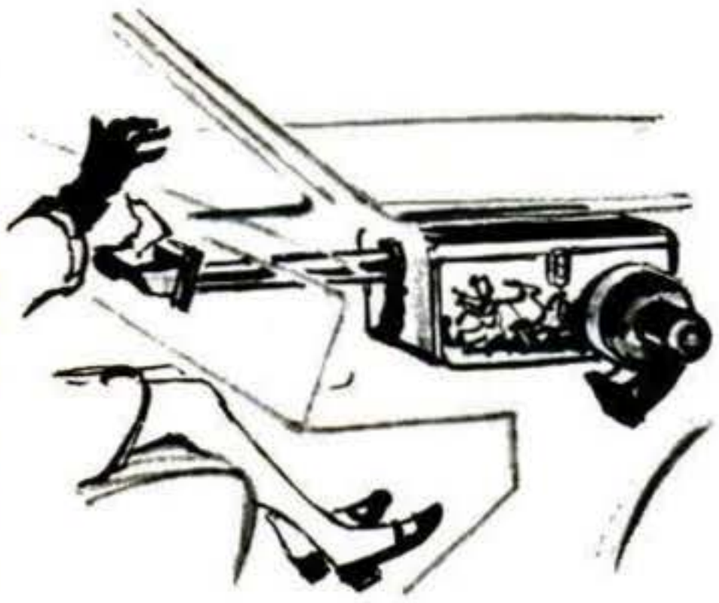
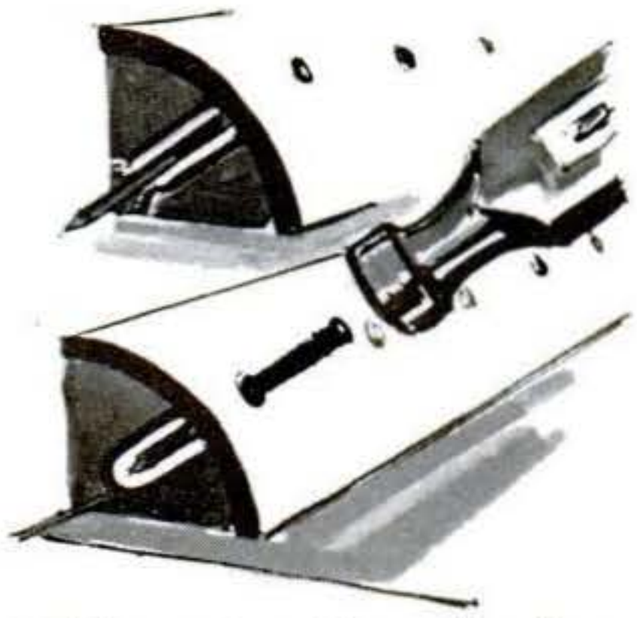


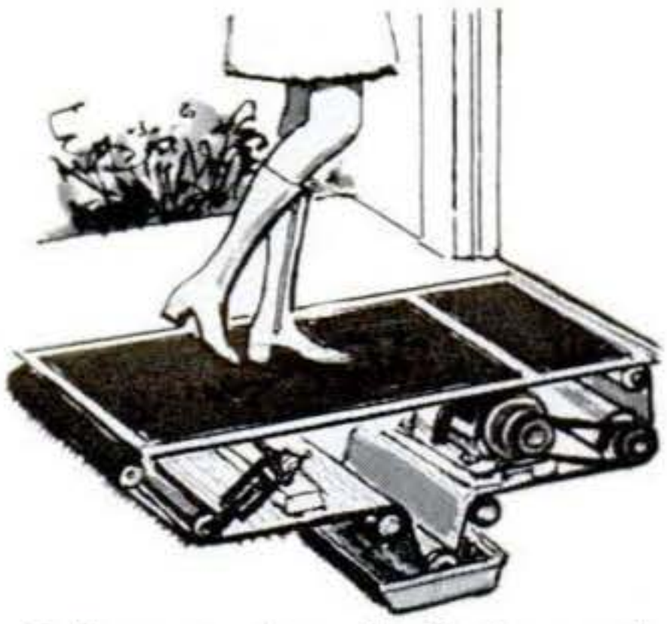
Vertical grid houses trailers. Lifted onto individual pads of this recently patented trailer park, house trailers might enjoy more privacy in a more attractive setting. A rooftop hoist would lift a trailer so its wheels could be replaced by castered rests. The trailer would then be positioned on a let-down gate, winched onto its pad, connected to building-type services.



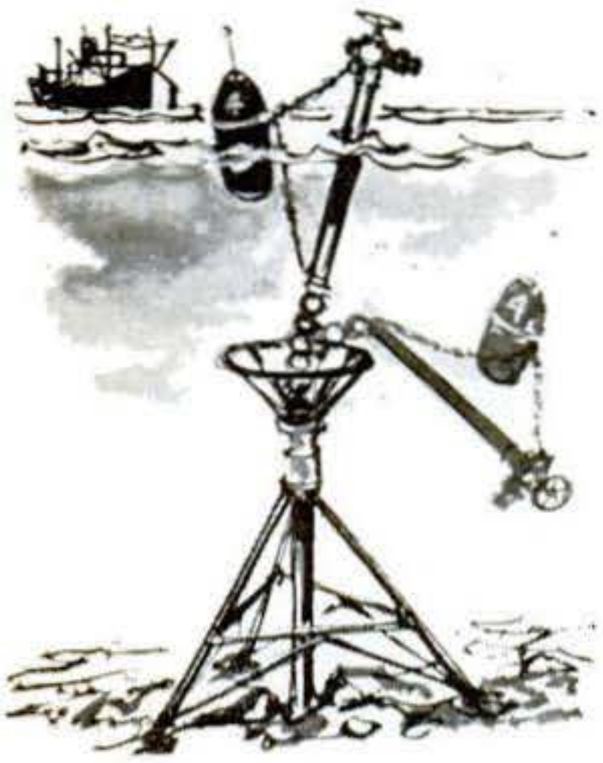
Car cleaner collects trash. A small suction fan and collection box under a car's hood would gather travel trash for easy disposal at any gas stop. Gated tubes in the dash would suck up litter at the touch of a switch. With flexible hose attachments you could vacuum up dust and bits of debris.



Molding strip guides nails. These tubular slots molded into a trim strip would position finishing nails uniformly and guide them accurately into place. Preformed openings would also insure against splitting the strip or marring the surface by pilot-drilling or needless off-the-mark hammering.



Roller mat cleans itself. Recessed into the floor of an entryway, this scrub cleaner would wash and dry the underside of a roller-mounted mat and expose a clean top section for better looking, more effective foot-wiping. Slow rug rotation could be automatic or switch-controlled to suit weather and traffic.



Buoy rises on signal. Offshore wellheads may present navigational hazards, and many have been damaged by storms. Both problems could be minimized, says this Mobil Oil patent, by keeping wellheads submerged between service periods. This buoy would be flooded to sink the attached lines, raised by a gas cartridge that would expel the water.

Rod drives stick screws. Fed into the barrel of this drill attachment, screws with shallow, reverse-threaded recesses in their heads could be assembled into sticks for rapid driving. Each screw would break off when the one ahead was sunk. An adjustable spring would maintain pressure. A free-turning sleeve would let you steady and guide the driver as it turned.

The following patents have been issued on these inventions: **Trailer park**—*No. 3,525,186 to D. Lombardo, N. Palm Beach, Fla.;* **Car cleaner**—*No. 3,500,492 to J. Coleman, Grand Bay, Ala.;* **Nailed strip**—*No. 3,504,473 to V. and J. Shanok, Brooklyn, N.Y.;* **Mat cleaner**—*No. 3,526,015 to J. Nappi, Berlin, Conn.;* **Buoy raiser**—*No. 3,487,486 to J. Leonard, Houston, Tex., and J. Terry, Whittier, Calif.* **Stick screw driver**—*No. 3,528,466 to Charles W. Tracy, Tallahassee, Fla.*

Copies of patents may be ordered, by number, from the Commissioner of Patents, Washington, D.C. 20231, at 50 cents each. To write to an inventor, address him (by name and patent number) in care of the Commissioner.

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"Say, Smokey—"

A clinic on cars by America's most famous mechanic

Each month in POPULAR SCIENCE Smokey Yunick answers questions on cars—family cars, high-performance jobs, hot rods, and racing cars—selected from those sent in by readers. Got a problem? Send it to: "Say, Smokey—" Popular Science, 355 Lexington Ave., New York, N.Y. 10017. Questions cannot be answered by mail.

Since the day of purchase I've been having trouble with my 1971 MG Sport. When pressing down on the accelerator, even after the MG is warm, it hesitates, then after three or more hesitations everything is normal. The mileage is 2,000 but the dealer says this reaction is normal—which I definitely don't buy. Also the engine idles at 700 to 1,200 rpm and won't hold a steady 900 rpm.

LESTER F. KIRCHNER, Bloomfield, N.J.

When you accelerate and the car hesitates, nine times out of 10 the cause is lack of fuel, due to such things as a worn-out accelerator pump, extra-big carburetors that have low velocities at low rpm, cold air/fuel mixes, improper ignition timing, or wrong range and type of spark plugs.

I purchased a 1966 Chevy Caprice wagon with a 396 engine in 1967. After 5,000 miles it was using oil at about one quart every 200 to 300 miles. The Chevrolet garage here put in new rings and said the original rings had not seated properly. Oil usage dropped to a quart every 1,000 miles. But now at 57,000 miles on the odometer I'm getting only 500 miles per quart. Mechanics tell me this is typical of the 396 engine. Can you give me any ideas?

M. H. LITTLE, Umatilla, Ore.

First—this is not typical of the 396 engine. But it is typical of a 396 (or any) engine that has bad valve seals and/or excessive crankcase pressure due to insufficient venting. It's also typical of a 396 with a smooth bore and chrome rings or a 396 that was given a super-additive that didn't let the rings seat in before varnish and shellac coated the cylinder walls. Take a good look at the valve seals. Do a cylinder leakage test. And check the crankcase pressure.

I just bought a 1934 Ford truck. It has the original flathead V8 engine in it now, but I'm planning to install a Ford 289. Is this possible without a lot of work, money, and headaches? Will the whole drive train have to be replaced?

FRANK MILLER, Canoga Park, Calif.

To the first question the answer is hell no! The drive train can go either way—most people change to an open drive line.

Can you tell me where I can write for information on the Cheetah, a race car designed by Bill Thomas? I haven't heard anything about it for a long time.

SCOTT MILLER, Park Ridge, Ill.

Locate Bill Thomas or Don Edmonds in the Los Angeles area, if you can, and start with them. I believe the Cheetah has joined the Hudson, De Soto, and Edsel among other old warriors.

I own a 1965 V8 Olds that has the little window in the distributor cap for adjusting dwell when tuning. I also have a 1971 Ford with 400 V8 engine. Is it possible to buy a set of points and distributor cap made for a GM car that will fit my '71 Ford?

FRANK FRANEK, Wolcott, Conn.

Nope. I believe your Olds distributor is in the back and your Ford distributor in front. As infrequently as it's necessary to change points, I doubt if it's worth a homemade deal.

My 1970 all-power 390 Mercury Monterey rides, runs, and handles fine. But it has one bug that's driving me nuts—a noisy speedometer. It started clicking at 300 miles. The agent's mechanic installed a new speedometer and cable at 4,720 miles. The original cable was a speed-control type, but he replaced it with a standard cable. Four to five hundred more miles and this became noisy, so in went another new set. At 12,000 miles it's driving me nuts again with all that clicking. It's worse between 45 and 60 mph, quieter above and below those figures. The mechanic is getting tired of my griping and says the only way he knows to get rid of the noise is to disconnect the cable entirely. Help!

HAROLD SMITH, Rockport, Mo.

Before you all start a war over this, get somebody to reroute the speedometer cable housing, and try to increase the radius that the cable works in. I think it's just working in a bend that's too tight.

I have a 1971 ¾-ton Chevy Sport Van, and my question is about brake performance. I've read several reports on vans that suggested poor braking ability, and get the impression that rear-wheel lockup on maximum effort causes loss of directional control. It could also cause increased stopping distances because of the need to let up on brakes to maintain control. Could I improve stopping ability by carrying 200 to 400 pounds in the rear to reduce the tendency to lock up—or would this weight just increase the stopping distance? How would the extra weight in the rear affect the van if it started to skid on wet or icy roads?

R. ANTHONY, Altus, Okla.

I would rather see you tackle this with more front brakes, or cut down on the rear-brake effort with an adjustable pressure compensator valve. But things like more rear weight, stiffer front springs, and wider rear tires will also help balance out the system. About weight: Assuming the brake system is balanced, as you increase the total weight, stopping distances generally increase. I say "generally" because tires must have a certain weight on them to reach their maximum adhesion.

I have a problem with my 1969 Olds Delta 88. Four months ago the carburetor was cleaned. Since then the engine starts well when cold, and if restarted a minute or two after stopping it starts well hot. But if I leave it for 15 or 20 minutes, then try to start, the engine will turn over eight to 10 times before starting, then put out a lot of smoke for a while. The local dealer put in new points, tuned the engine, rechecked the carb, and finally said the starter was not turning the engine over enough to start it. Then they overhauled the starter—total cost $90! The motor turns over fine, but it still acts like it did all along. What next, to avoid bankruptcy?

J. M. JENKINS JR., Castle Hayne, N.C.

When the car sits a while I'm afraid your carburetor fuel is leaking into the manifold when it's hot. It's my guess that you're not going to be happy until the carb is worked on one more time. I believe your "smoker" is raw fuel. A good check would be to remove the carburetor top and see how much fuel is left after sitting hot for 15-20 minutes.

In my 1957 Chevrolet the power-steering unit seems to use a large quantity of type A automatic transmission oil. I fill it regularly to the proper level, yet it disappears overnight. But where? There are no obvious signs of leakage.

LARRY DAVIS, Parsippany, N.Y.

Get some mineral spirits, or another safe cleaning fluid, and wash down the pump, hose, and steering-gear area. Fill up your steering pump as your owner's manual directs. Then, with everything clean and dry, drive 20-25 miles, and take a good look. It's leaking out.

I have a 1967 Ford station wagon with 390 V8 engine and no A/C. The heater won't heat up to par. On medium blow and on defrost I get just enough heat to keep the windshield clear. If I put it on high blow, or switch to the floorboard fan, I get nothing but cold air. Different mechanics and the Ford dealer in town have done the following: replaced thermostat three times, replaced

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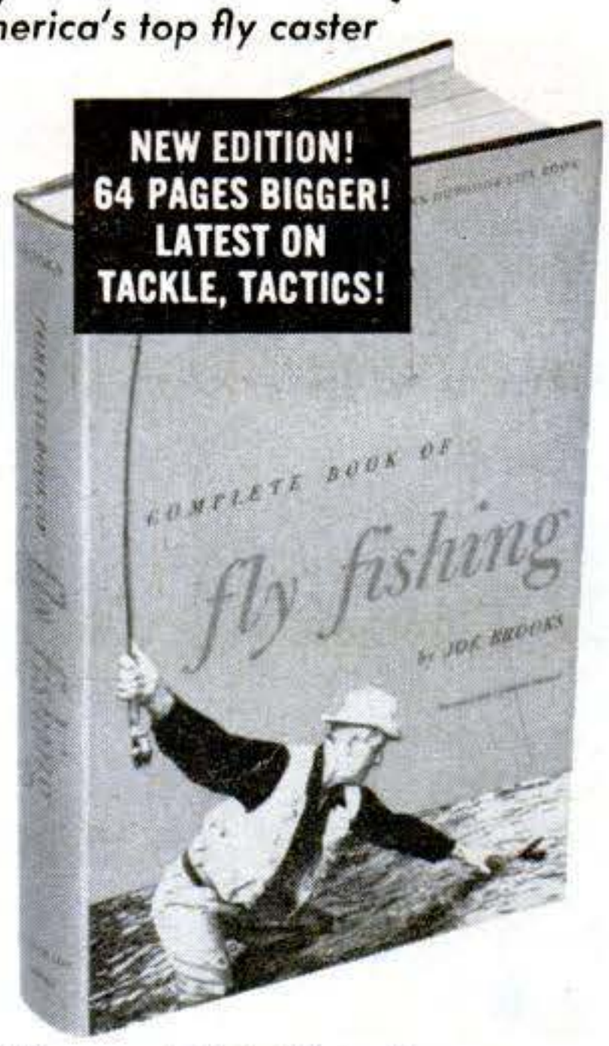

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"Say, Smokey—"

[Continued]

radiator cap five or six times, replaced all heater hoses and bled for air, flushed the system, gone over the radiator and heater core, replaced the intake manifold gasket, replaced the water pump, and tried different types of antifreeze. I give up. Any ideas?

JACK ROOT, Minot AFB, N.D.

Get a clear piece of plastic hose, for checking purposes only. Put this in the return side of the heater core to the radiator and you'll find no circulation. Find a hot-water outlet around the water-pump push side that will force hot water through the heater core. You've got to get hot-water circulation before anything warm happens.

A question about springs on a 1963 Fairlane, bought new and now using Sears Michelin tires: To stiffen the springs I had plastic coil-separators installed in each front spring and the sagging back springs raised by peening each leaf and adding one long leaf. One coil broke off the bottom of each front spring, and the rear springs sagged back to original position after about 35,000 miles. Are coil-spring separators and peened leafs good fixes?

ALLEN TRASK, Utica, N.Y.

At the risk of making you think I'm a smart alec, it would seem you answered your own question about springs the hard way—in 35,000 miles. Obviously, any fix that breaks down like that one did provides its own demonstration.

At 19,000 miles my 1971 Karmann Ghia has a starting problem. After it sits for 10 minutes or more I have to crank it for at least 30 seconds. Then it floods so that I can smell the gas—and then starts. It always starts. The dealer changed the carb (twice), the fuel pump, the distributor, and even replaced points and plugs. What have we overlooked?

DONALD B. RAYFIELD, Rocky Point, L.I.

I think your problem is caused by hot fuel. Gasoline boils at a very low temperature, and also expands greatly at 100-110 degrees F. Fixes that would cool the fuel even 10-15 degrees would probably correct this problem. When a hot start is attempted, a fuel-pressure check between the fuel pump and carburetor would probably indicate that this is a hot-fuel problem. Your carburetor can handle about seven or eight p.s.i. I'll bet that when the engine is hot, the pressure is going up to 13-15 p.s.i.

The inside and outside edges of the front tires of my '69 Ford Country Squire are wearing excessively. Local dealers have checked and reset almost everything, but the wear continues. The rear tires are okay. What's the problem?

JEFF PAYNE, Stamford, Conn.

Sounds like you need to put in more air than recommended. Apparently your wagon is heavy enough in front to flatten the center of the tires, and the weight is carried on inside and outside edges. PS

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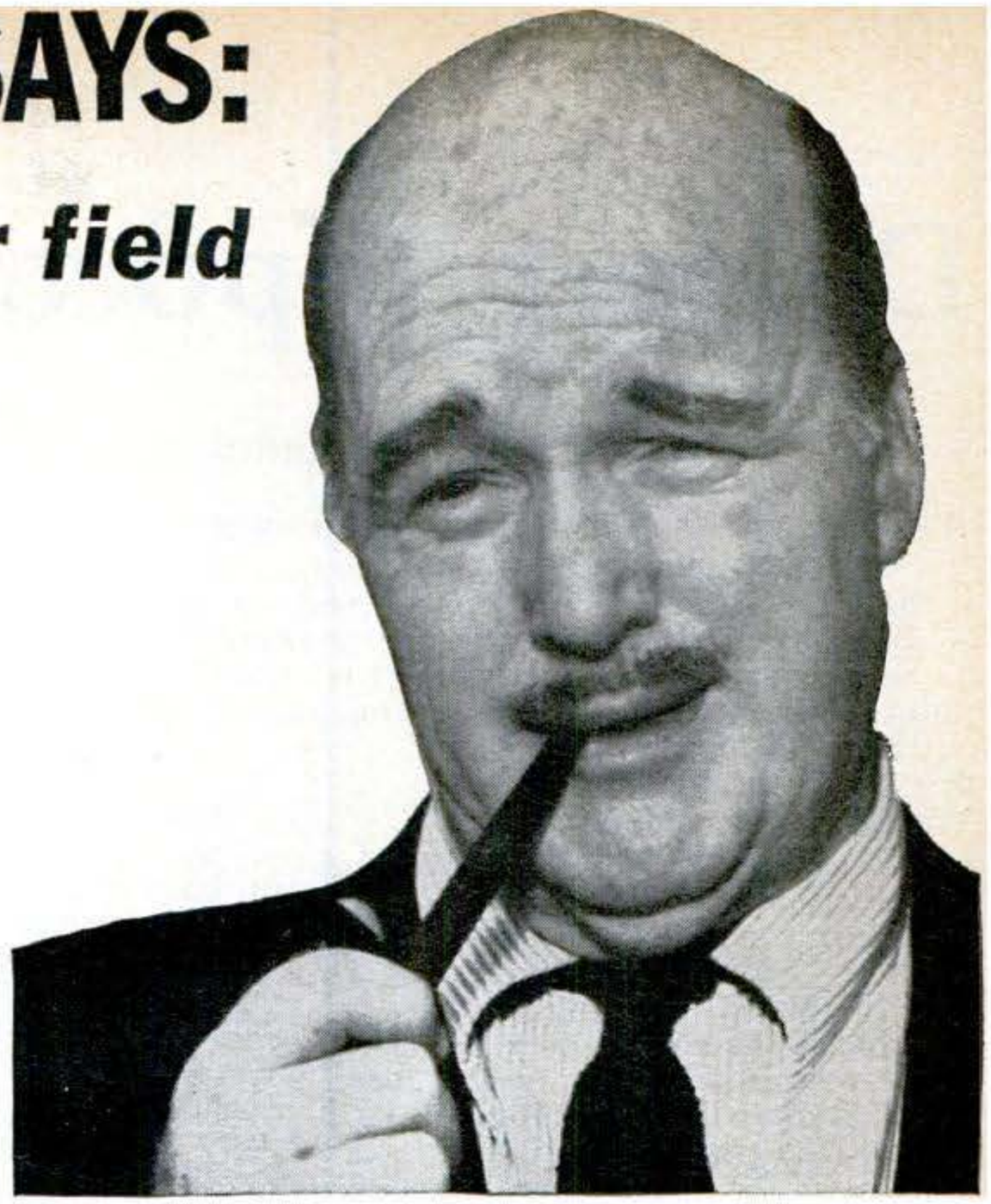
TOM McCAHILL SAYS:

"The appliance repair field is so uncrowded it's almost lonely!"



Someone once said that if you build a better mousetrap, the world will beat a path to your door. In the home appliance business, a lot of enterprising companies have gotten rich peddling a long list of handy electrical gadgets for the home. The trouble is, the dozen or more appliances in the average American home can go on the fritz, and men with the proper training to do repairs are as scarce as knee-length skirts on teen-agers.

Good Appliance Repairmen are a rare breed these days. Those with a little ambition are booked so solidly you can wait days to get somebody to fix a balky refrigerator or cantankerous toaster. Sometimes, you have to settle for a bum job from a guy who had no business calling himself an Appliance Repairman in the first place.

This brings me to my point. If you want to make money in a field that's begging for trained technicians, there's a fine, low-cost home-study plan available that teaches you how to handle every type of Appliance repair in detail — including refrigeration, air conditioners, and even small gas engines. The course was prepared by the instructors at National Radio Institute. This is the oldest and largest home-study school in the Electronics/Electrical fields with more than fifty years' experience training men like yourself for new careers or spare-time or full-time businesses of their own.

A few years ago, NRI recognized the increasing demand for trained Appliance Repairmen. They set about preparing well-illustrated, easy-to-understand lessons that teach you how to repair home, commercial and farm Appliances. NRI even added a professional Appliance Tester that's included in their low tuition. With the Tester and a few basic tools you probably already have, you're equipped to service most Electrical Appliances. If you aren't making $5 to $7 an hour in spare time fixing Appliances for friends and neighbors within a few months after enrolling, my name isn't McCahill.

The reason I'm no doubting Thomas, is because the staff at NRI is composed of experienced instructors who guide you through the course with more personal attention than you'd get in many classrooms. With the kind of help they give a student and the kind of course they have, you can be the man in demand in this field — even if you've never rewired a plug, or got fed up with school at the 9th grade.

The best advice I can give you is to clip the coupon below and send for the NRI Appliance Training Catalog. It's free, and there's no obligation. NRI doesn't employ salesmen, so nobody will be knocking at your door. All it will cost you is a postage stamp. Take it from Uncle Tom, the Appliance Repair field needs good men. Now.

Tom McCahill

Tom McCahill

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Detroit Report...

By JIM DUNNE / *PS Detroit Editor*

A look into the crystal ball: Best wheels forward?

"By 1990, more than 90 percent of the cars will be front-wheel drive," says one of Detroit's top product planners. And he may be conservative in that prediction. By now it is crystal clear that front-wheel drive holds more attractions for the auto companies than any other power-train layout. General Motors is expected to build most of its Wankel-powered cars with front-wheel drive. Those cars will show up in the next three years.

Wankel power

Now that Ford has signed a Wankel agreement, the race is on to see which company will be first to offer the rotary engine in an American car. Possibilities are growing. Ford can bring in the Wankel from Germany, where it is licensed to build it, or, if the plans to obtain part ownership of Toyo Kogyo are completed, it can bring in the Japanese engine. In either case, Ford has the option to import a complete automobile, or the engine alone. The company has tentative plans to exchange bare engines here and overseas—build a new Pinto engine here for overseas use, and bring in a Wankel to power a Pinto-size, or smaller, car.

Chrysler will be next to move. Its ties with Curtiss-Wright will give it a good start in Wankel development, so it should not be far behind Ford and GM in coming up with an engine. And, as reported last month, American Motors is expecting to use the GM engine when it is made available.

Secret-keeper

Security in automobile plants and offices has tightened up markedly in the past 24 months, in keeping with the times. General Motors, taking a page from government practice, is shredding all important documents after use. The company moved a huge paper-shredding machine into its headquarters in Detroit late last year to take care of messages flowing to top executives. GM was recently stung by the discovery that Corvair complaint microfilms, which should have been burned, were being sold to the highest bidder by a surplus store. GM never moved faster in coming up with the $20,000 asking price to buy the records back. Now GM is grinding up its secrets without delay, right on the premises.

Cadillac interurban?

Detroit has been dead set against highway taxes going into mass-transit systems, but signs now point to a change in attitude. Ford has opened a new transit-systems design department at its Design Center in Dearborn to work with outside agencies in development of new concepts in public transportation. And GM has always had a mass-transit program on the shelf, ready to show the public that it is all in favor of an alternative to the private motor car.

The auto companies are reacting to moves by the government to free highway money for development of mass-transit systems. Auto makers want to get in on the movement before it develops. Highway money, collected through gasoline taxes largely, has been used mainly for highway construction and maintenance. But now lawmakers reason that building mass-transit systems would benefit drivers by taking pressure off public roadways, so some funds should be spent on mass transit.

Weight watcher

Your future car's size and weight could be dictated by Washington. That's one conclusion Detroit insiders reach when eyeing federal government experiments, especially the big-vs. small-car crash tests. These tests show—as anyone could have predicted—that smaller cars fare poorly in collisions with large cars. The next step is to set weight limits so that all cars have an equal chance in a collision. The government has already done this in its safety-car specifications, setting a 4,200-pound maximum. It is a simple step from this to passing a weight standard for production cars.

Aluminum bumpers

Aluminum producers have long yearned to supply their lightweight metal for automobile bumpers. Only an aluminum engine ranked higher on their list of priorities in the automotive field, and with the introduction of the Vega that first goal was once again realized. Now it seems that the aluminum-bumper goal will be reached in the near future, too. The first break came when aluminum was mentioned as a possible metal in the new heavier bumpers now mandatory on 1973 models, the systems that must protect a car in 10-mph car-to-car crashes. Aluminum would cut down the weight of these huskier bumpers. Further encouragement came with the news that GM, Ford, and AMF are using aluminum extensively in the bumper systems of their experimental safety vehicles. AMF claims that it saves 450 pounds per bumper, or almost 10 percent of the curb weight of its safety car.

Bright lights

Better night vision for drivers is apparently on the way. High-intensity iodine-quartz and halogen-quartz headlamps, outlawed in many states, will be standard equipment on new cars within the next few years, according to some experts. The brighter lights, widely used in Europe, have the backing of Douglas Toms, the government's safety chief, who plans to issue a proposal to legalize the systems here. One result is that the candlepower of the headlights will be doubled from the 75,000 developed by present sealed-beam lights. Other lighting changes that may be dictated by Washington are dual-intensity brake lights that are brighter in daytime than in darkness, and rectangular headlamps that provide a more usable beam of light than the present round style. Leading makers of iodine quartz lamps are Cibie and Marchal in France, Hella in Germany, Carello in Italy, Philips in Holland, and Lucas, Miller, Raydyot, and Stadium in England.

Permanent plugs?

Spark plugs are now getting a close look from General Motors to see if a new design will last the life of the car. Two divisions, AC and Delco, are working on the problem. Pontiac experienced fantastic long life from standard plugs installed on the fleet of cars that tested the electronic ignition used on its 455-cu.-in. engines. Up to 50,000 miles was recorded for these plugs when lead-free fuel was used. If this is true with ordinary plugs, GM reasoned, what will happen if the plug design is improved? That's the basis for the present spark-plug program. A bonus from the program will be cleaner emissions that will result when long-life plugs insure good burning in the engine, long after ordinary plugs begin to misfire.

The bug killer that failed

Two years ago, when Ford was basking in Maverick's initial successes, an executive at the company predicted in this column that VW would "no longer be a factor in the U.S. market" by July of '71, and that safety would kill off the Beetle. I rechecked with the Ford man after noting that VW held a lead (about 317,000 cars) over Pinto (190,000) for 1971 through July. He repeated that the VW's future, in his estimate, was grim, though he offered no explanation for the continued strength of the German auto maker. It is interesting to note that this same executive was actively involved in Ford's famous Edsel debacle.

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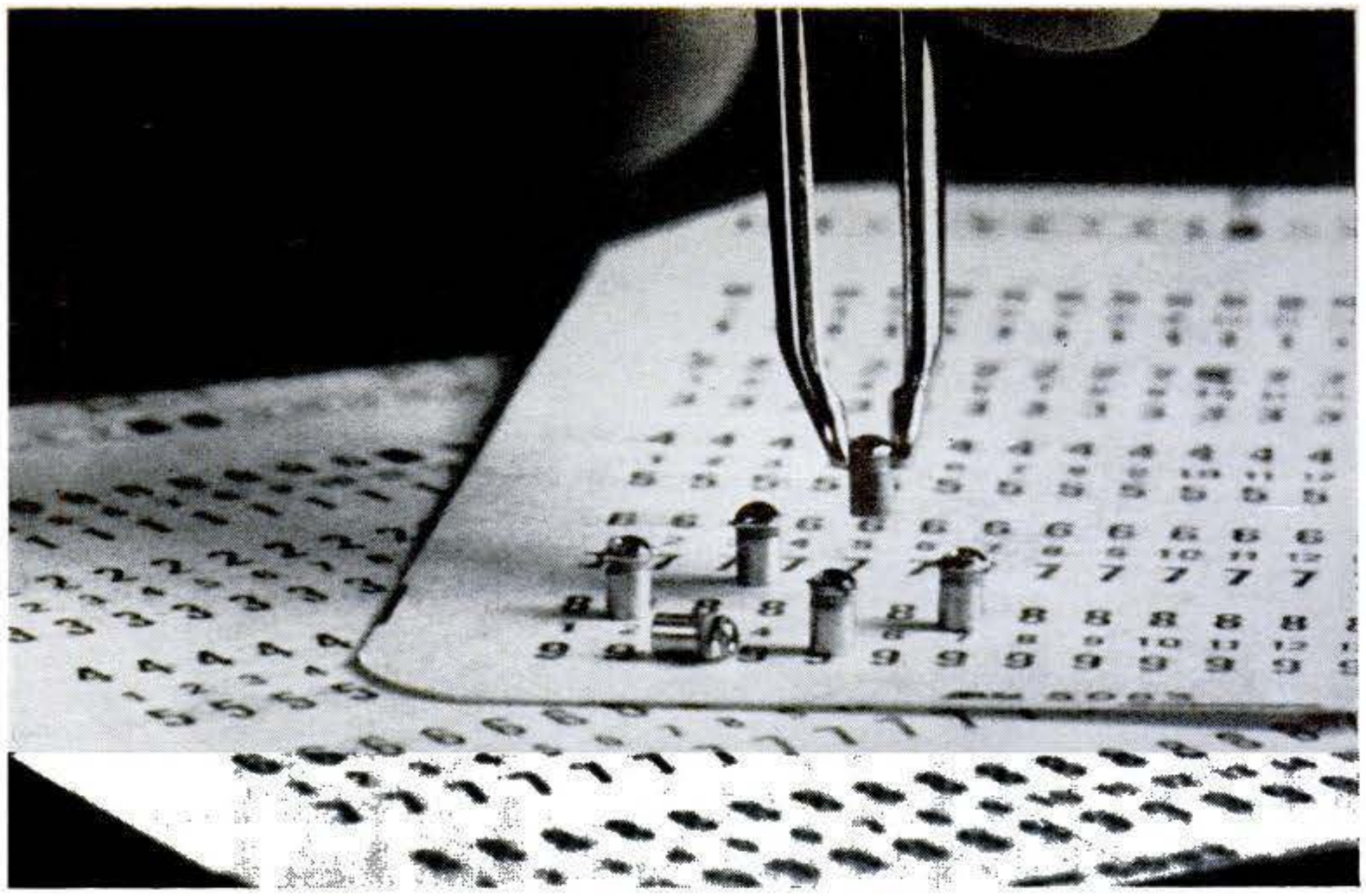
Science Newsfront

Last-minute news and notes to keep you up-to-date

By ARTHUR FISHER

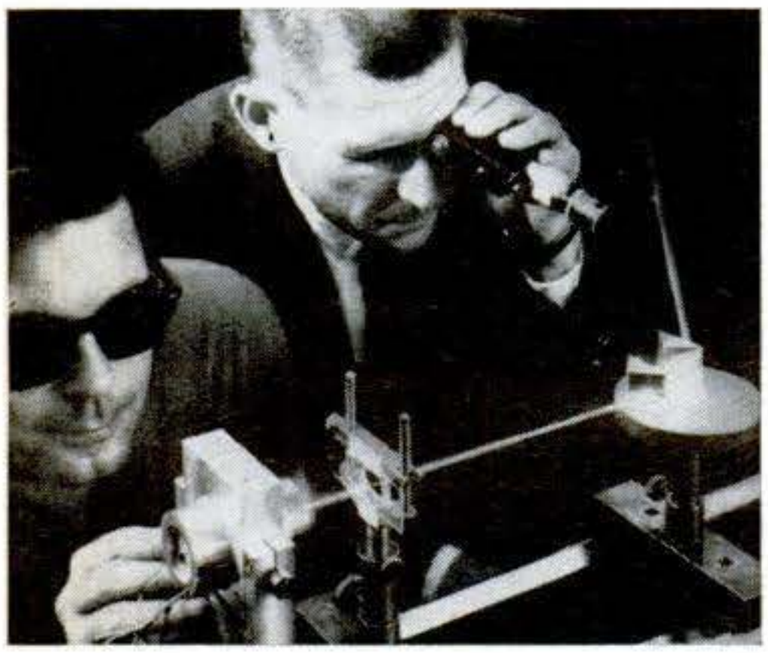


LEDs used for switching in card-punch system

Light-emitting diodes are now acting as part of a switch that detects the presence of a punched card. In a new IBM system, the semiconductor devices emit invisible infrared light, which is sensed by a phototransistor. When a card breaks the light beam, the "switch" is transmitted as information to the machine's controller.

Spectroscopic success

A new optical device that may improve spectroscopic examination in dramatic fashion has been developed at the Electro-Optics Organization of GTE Sylvania, Inc., by Dr. J. Michael Yarborough and Dr. Gail A. Massey, shown here demonstrating it. Called a visible optical parametric generator, the device is related to the new breed of tunable lasers. It consists of a crystal placed in the path of a focused laser beam. Rotating the crystal yields short, intense pulses of coherent light at any desired



frequency of visible light. Because the crystal acts as a light amplifier, critically aligned mirrors that are typical of other tunable devices are unnecessary.

In spectroscopy, scientists analyze a substance by examining the spectra of light emitted or absorbed by it, then matching these spectra with the known "fingerprints" of elements and compounds. The new device should improve such analysis and permit, according to its developers, "research into the transient behavior of atoms."

The happy hunting ground

Commenting recently on the search for more and more complex organic molecules in outer space, Dr. William Fowler, the renowned Caltech astrophysicist, said: "The discovery of ethyl alcohol molecules in the interstellar gas would make me very happy. What will be the point of going to heaven, otherwise?"

Life in space?

Meanwhile, two scientists at Columbia University have succeeded in synthesizing amino acids—the basic building blocks of life as we know it—from materials known to exist in outer space, and without water! Goesta Wollin and David B. Ericson, of Columbia's Lamont-Doherty Geological Observatory, mixed three gases—ammonia, methanol, and formic acid. The gases formed a colorless liquid (the scientists report they rigorously excluded water from the mixture), which they then exposed to ultraviolet light from a common sunlamp (space is bathed with uv radiation). After 25 days, a number of amino acids had formed—all of them found in the protein of living cells. The two men believe their experiment suggests that life might form in a waterless environment, such as the moon.

Natural radiation levels

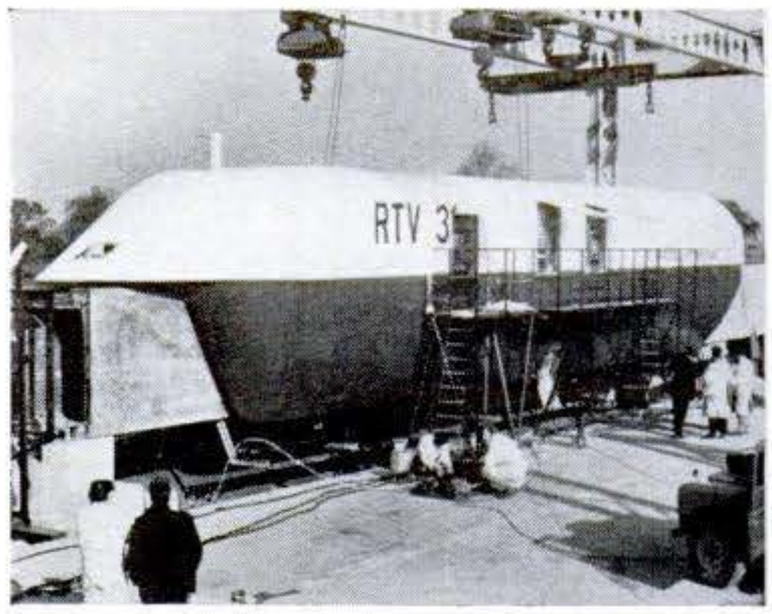
How much radiation from natural, or "background" sources do you get? It depends on where you live. A federal agency has released a study showing the average background radiation state by state. The U.S. overall average is 130 millirems per person per year, but there are some significant variations. Coloradans, for example, get 250, Texans 100.

New time scale

You may not know it, but last month a whole new way of keeping time went into effect. On January 1, the nations of the world switched to a scale based on atomic seconds, which are slightly shorter than the astronomical or earth seconds previously used. This means that scientists and others who need to keep track of time precisely will have to use "leap seconds" to make up the difference. Thus the National Bureau of Standards will have to set back their clocks by one second about once a year. Don't forget now.

Hovertrain gets off the ground

A prototype of the world's first tracked air-cushion vehicle (TACV) has successfully hovered clear of its concrete track. The 50,000-pound vehicle—dubbed the RTV 31—represents England's hopes in the high-speed ground transport race. It is an automatic, driverless, 300-mph hovertrain powered by a 5,000-hp linear-induction motor. Air for the vehicle's hoverpads is blown by an experimental fan installation. The successful lift was



made by operating at only 75 percent of fan lift power. The vehicle's developers, Tracked Hovercraft, believe it will be five to seven years before fully tested TACV's are in service.

Getting the lead out

An unusual coalition of private industry, public groups, government agencies, and a university medical center has formed in Rochester, N.Y., to combat a growing environmental health problem—lead poisoning in children. Staff members of the University of Rochester Medical Center Department of Pediatrics screen inner-city children who live

Continued

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And you could hardly find a more dependable way to see it than in the Chevy Nova.

Actually, this year's Nova is pretty much unchanged from last year's Nova. The car independent auto mechanics said was "easiest to service" and had the "least mechanical problems." (Compared to *all* cars, in a survey conducted by *Motor Service* and *Service Station Management* magazines.)

With a car as dependable and economical as Nova, you don't go redoing it from one year to the next.

Mechanical improvements, yes. Like improved emission controls for cleaner air.

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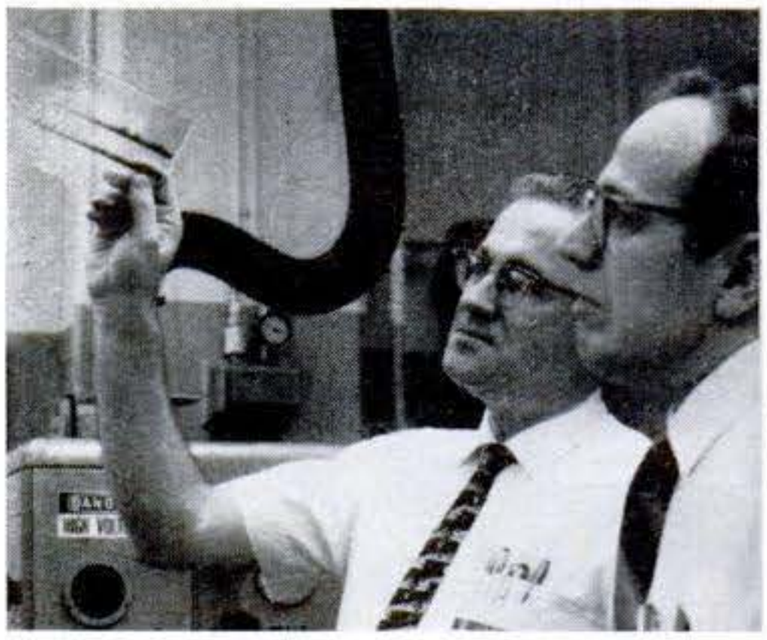
in areas where exposure to lead is high—from chipping and peeling lead-based paints in older buildings, auto exhausts, food and water, and even the paint on pencils. When they suspect lead poisoning, the physicians send blood samples to Eastman Kodak's Industrial Laboratory, which specializes in the detection of trace elements. There, chemists perform



a highly sophisticated procedure called emission spectroscopy to determine the level of lead in the patient's blood. (The photo shows two chemists at the Lab examining emission spectrographs.) Normal adults may have as much as 20-30 micrograms of lead per 100 grams of blood, or about one part in five million. Doctors begin to worry when the level in children reaches 60 micrograms.

At the same time, citizens' groups and local government bodies have joined to decrease the number of persons exposed to lead by eliminating lead paints in inner-city buildings. The coordinated effort has so far been funded in part by the federal government, with Kodak contributing its test facilities.

Tests sneeze at vitamin C

Does vitamin C have any value in warding off or helping cure the common cold? Nobelist Dr. Linus Pauling says yes in a best-selling book that produced a tremendous run on the compound, which is now being gulped by hopeful thousands of cold victims. But a recent controlled experiment, performed by University of Maryland researchers, produced no support for Pauling's theories. The investigators inoculated 21 healthy male prison volunteers with rhinovirus 44, a cold-causing virus. In the double blind test, 11 of the men had received three grams of ascorbic acid (vitamin C) a day for 14 days previously; the others had been given placebos (dummy pills). Both "treatments" were continued for a week after the inoculation.

Result: All 21 subjects developed those all-too-familiar cold symptoms 12 to 24 hours after being inoculated with the virus. There was also no significant difference between the two groups in the severity or duration of the colds. The researchers cautiously added that although the experiment did not substantiate the claims made for vitamin C, it did not absolutely rule them out, and further tests using larger groups and perhaps larger doses might be needed. PS

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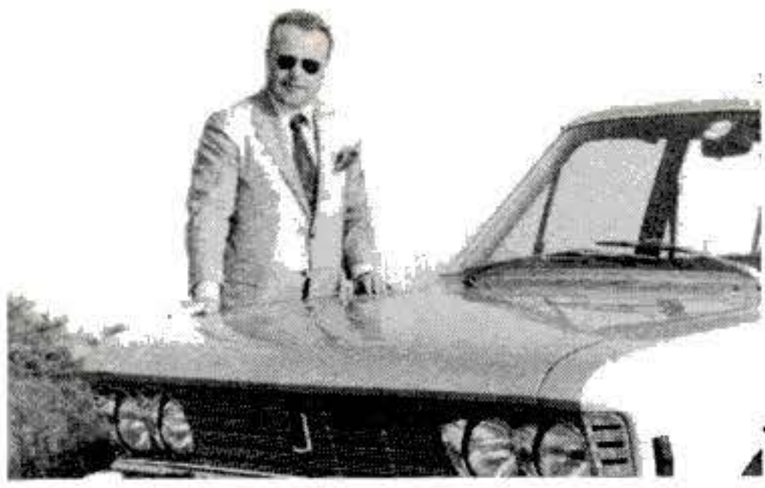

The View Down the Road

...news and comment on cars and driving

By **JAN P. NORBYE** / *PS Automotive Editor*

Should the Big Three be broken up?

You've heard it before, I know. But now all the reasons why the Big Three auto companies should be broken up are collected in one book, supported by eloquent argumentation from a young Princeton University economist, Dr. Lawrence J. White. He examines the record of GM, Ford, and Chrysler from 1945 to 1970. He says they enjoy an oligopoly—an overly large concentration of economic power—the same thinking that led the Antitrust Division of the Department of Justice to make recommendations for breaking up both GM and Ford.

But Dr. White also looks beyond. He looks at the product, and that's what you and I care most about. He says product innovation is low. He has a point, but I would express it differently. Detroit has a good record of innovation in the 1945-70 period (automatic transmissions, power steering, disk brakes, and many lesser developments). What bothers me is the lack of product *diversification*. There's a depressing sameness about Detroit cars. Ford, GM, and Chrysler are all making the exact same kinds of automobile, pound for pound, dollar for dollar.

Could Olds survive without GM?

I have heard talk of spinning off Chevrolet for 10 years now. And, frankly, if that happened, it would be more serious for the other divisions than for Chevrolet.

Olds and Buick would be in trouble. Dr. White suggests Olds could merge with Cadillac, Buick with Pontiac. For the other companies, he would leave Lincoln-Mercury together, but divorced from Ford, and cut Plymouth off from Chrysler and Dodge. If Dr. White had his way, the Big Three would be split into seven firms. With American Motors, that would yield eight firms in the industry.

I talked to Dr. White about these ideas, and he said his main aim was to demonstrate the need for breaking up the giant auto companies. He was not proposing a master plan for distribution of trade names and manufacturing facilities—merely pointing out a way it might be done.

Expectedly, he had little to say about GM's other divisions (AC, Delco, Saginaw, Detroit Diesel Allison, Guide Lamp, Harrison Radiator, Frigidaire—or even Fisher Body). For the car divisions, he did envisage that each one could take care of its own engineering and advanced product planning. And that, perhaps, might lead to a lot more diversification in American cars.

Dr. White had no solutions for how to split up the proving grounds and other test facilities, the corporate research and development organizations, or corporate styling staffs and their physical equipment. All these functions are vital to auto production.

The transfer of personnel might take a natural course once the breakup were ordered. But how to allocate real estate and other assets? Some divisions could no doubt survive as independent units, but the corporate services are in a different class. They are almost symbols of the interdependence between the car divisions and must be broken up if the dream of product diversification is not to be shattered.

The trouble with price overlap

One of the first things Alfred P. Sloan did on assuming the presidency of General Motors in 1923 was to eliminate price competition between the divisions. Each was given its own niche, where it had plenty of competition from outside.

Price overlap began to creep in around 1931, and was strong by 1939, as a result of growing parts commonality and standardization. Now price overlap is so unrestricted that Chevrolet competes in all price classes short of Cadillac; and Pontiac, Olds, and Buick have all but total overlap.

What do you think would happen if GM's top management ordered a strict return to Sloan's original principles? It would make for a very interesting line-up of cars, the way I see it. Chevrolet would only have the Vega and the Nova. Pontiac would only have the Firebird and the Le Mans. Olds would have the Cutlass and the Delta 88. Buick would have the Electra and the Riviera. Cadillac, no change.

Now, let's try the same idea over at Ford. Ford cars would be Pinto, Maverick, and Mustang. Montego and Monterey would go to Mercury. Lincoln would remain Lincoln.

In this system, there's no room for an LTD or an Impala. Ford and Chevy are assigned to the low-price market—and a price ceiling restricts size, too. Other superfluous models, created only for marketing purposes, would be eliminated. What's more, the price for a new Ford or Chevrolet would not seem so excessive. With the Nova as the top of the line, Chevy prices would not be too far out of line with 1950!

Caution on mass transit

To get to my office, I use the New York City subways. I avoid driving around town whenever I can. Naturally, I'd like more-modern mass transit. I'm excited about San Francisco's BART, for instance.

But there are things mass transit can't do. I was driving from Phoenix, Ariz., back to New York last year, going through Indiana. And the town of Indianapolis was on my direct route. The way I got to the other side was just perfect, though. Indianapolis has a peripheral highway as part of the Interstate Highway System, so I went *around* the town.

Mass transit wouldn't have helped me. How many are in the same boat? Ford president Lee A. Iacocca says: "Philadelphia and other major East Coast centers are special cases, but it has become well established that the majority of people driving on downtown streets in most cities are not on downtown business. They are just trying to get to the other side of town." Moral: Don't stop mass-transit projects, but let's not forget road building, either.

New electric car from EFP

Last year we gave you an enthusiastic report on electric vehicles built by Robert R. Aronson [PS, Feb. '71]. His newest prototype, called Santa Fe, is actually a converted Matador (that's American Motors' six-seater intermediate). It carries 2,400 pounds of 150V DC batteries and a 390-pound 40-hp motor. Aronson claims maximum range of 100 miles at 55 mph, and 70-mph top speed.

Would you buy one? No? Not even if recharging stations were handy? Maybe I wouldn't either. This car fits into the local-traffic picture very nicely, but suppose you suddenly have to drive to a town 400 miles away? Unusable. The key word, I think, is "local." A car of this size could perform well in airport-to-city service, for instance, and fill a number of other taxi or limousine functions.

Next question: Is it economical? I don't know. Until this point is cleared up, the electric car will remain on the other side of the technology frontier, awaiting a breakthrough in: a) batteries, and b) motors.

Where to look? Perhaps the zinc-air battery, or lithium-chlorine and lithium-tellurium cells. Perhaps even the silver-zinc battery. As for motors, the breakthrough may come in permanent-magnet motors, homopolar motors, or AC induction motors. PS

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A machine famous for not breaking down.

1972 Maverick 2-door Sedan shown with optional Accent and Protection Groups, white sidewall tires and tinted glass.

Seems like most machines you buy today end up costing you more money just to keep them running. That's what makes Ford Maverick so exceptional. Maverick is a simple, uncomplicated machine —so there's less chance of *anything* going wrong. What's more, a good-looking, family-sized Maverick can be yours for surprisingly little money. Standard 6 or optional V-8. 2-door, 4-door or sporty Grabber.

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PS: What's News...

Keeping You Posted from Behind the Scenes

The picture tube shown on our cover this month and described in the story on page 64 may prove to be the answer to a dramatically cheaper and more reliable color TV. Those of you who keep your back copies of PS will find it interesting and instructive to look up a story on page 80 of the August, 1963 issue. You'll find a diagram and description of the Goodman tube. The operating principle was very similar to that of the Uniray except that X rays instead of light were used for indexing the electron beam to insure registry of the different color signals. The main problem with the Goodman tube proved to be random X rays within the tube that would give false indexing signals.

By the way, I hope you didn't waste too much time puzzling over how a picture of the Sea Knife (story page 99) showed up on our disembodied cutaway of the Uniray tube for our cover illustration. While artist Ray Pioch was out in Pittsburgh making his sketches for the painting of the tube, photographer Ozzie Sweet was getting soaked photographing the Sea Knife down in Maryland. The two illustrations never met until they were married in the photo lab in New York.

A price war on quartz watches?

When we were researching last month's story on quartz watches, the people at Bulova urged our author to delay the story. No reason. Just wait. But Timex had already told us they were announcing their remarkable break in the price barrier on quartz watches in January so we saw no good reason to wait. Now we know what they knew but wouldn't tell: Bulova has beaten the competition to market with a realistically priced quartz watch. In December they started selling their new Accuquartz watch through selected dealers in Manhattan for $395 in 14 K gold. Later this year they'll offer it in stainless steel at $250. (Photo shows Bulova's original $2,200 quartz watch, top; new $395 Bulova, bottom.)

The Accuquartz differs from previous quartz watch designs in several important ways:

- It was specifically designed for volume production on an assembly line.
- The movement is miniaturized to the point that it is smaller than many conventional wristwatch movements.
- It uses a quartz-crystal oscillator as the master frequency standard *and* a tuning fork to drive the hands on the dial and the day and date indicators. The Bulova people say the watch can be regulated by a factory expert to the fantastic accuracy of one-tenth of a second per day!

What time is it, really?

Most of you know that you can get highly accurate time signals from short-wave radio station WWV, but did you know that you can get similar time signals for the price of a station-to-station telephone call to Fort Collins, Colo.? The number is (303) 499-7111. The service is provided by the National Bureau of Standards and is the most accurate time signal available by phone. A handy way to check your new quartz watch.

Wordless in space

Our ingenious cartoonist and sometime inventor, Roy Doty, who draws Wordless Workshop, got an unusual long-distance phone call the other day. It was from the patent attorney for an aero-space company. He wanted to know whether the tool-holding device shown in Wordless in the February, 1971 issue was patented. It seems their engineers think Doty's device would make a good tool holder for a space capsule they're working on. Magnets were no good because they would louse up some of the capsule instrumentation. Brushing aside the temptation for profit, Doty admitted he hadn't thought of applying for a patent.

Tektite lives on

A permanent marine-research project known as the Puerto Rico International Undersea Laboratory (PRINUL) is an extension of the Tektite I and II programs that took place in the Caribbean in 1969-70 and were described in stories in the November, 1969 and October, 1970 issues of PS. Scheduled to commence operation in September, 1972, PRINUL is centered around a habitat designed to allow scientists to live for extended periods at depths of 100 feet and provide a base for excursions to 300 feet. It will operate on a continuing basis and be available to scientists and engineers from government, industry, and the educational communities both in the United States and abroad. With the accelerating interest and activity in exploring and developing the ocean's resources, an important function will be training divers, diver-scientists, and diver-engineers in the operation and effective use of an underwater habitat.

One hundred years of Popular Science

Our 100th anniversary issue in May this year is shaping up in fine fashion. We have agreement now from a number of top scientists, including several Nobel prize winners, to write articles for it.

Maybe you can help us in our search for an intact copy of the first issue dated May, 1872. We have it in a bound volume, but the cover and the advertisements were removed before binding. We'll pay $100 for the first copy we receive.

Hubert P. Luckett
Editor-in-Chief

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UNIRAY—Amazing One-Gun

With just a single electron beam, this tube is brighter, cheaper, far more reliable

By RONALD M. BENREY

At long last, the complicated, finicky, and expensive "shadow-mask" color-TV picture tube may be heading toward obsolescence.

Late last year I viewed the prototype of a revolutionary color picture tube—the brainchild of David Sunstein, a Philadelphia engineer—scarcely more complex inside than a black-and-white picture tube. I saw a bright, sharp, full-color image that impressed me as the equal of the best picture produced by any 1972 color TV. Yet Sunstein's tube:

- Has but a single electron beam inside to "paint" the picture across the screen—not the *three* beams of a conventional color tube.
- Needs no "convergence" circuitry—magnets, coils, controls—to bring the electron beams into alignment.
- Can live with a simpler high-voltage power supply because it operates at a lower beam current.
- Has no hard-to-make perforated steel shadow mask (we'll explain its function in a conventional tube shortly), and doesn't need a high-precision faceplate.
- Is not particularly sensitive to magnetic fields, so the shielded loudspeakers and elaborate automatic demagnetizing ("degaussing") devices of conventional color sets aren't needed.

Total all these minuses. The result is a big plus: The "Uniray" tube (as Sunstein calls it) can save money all along the line.

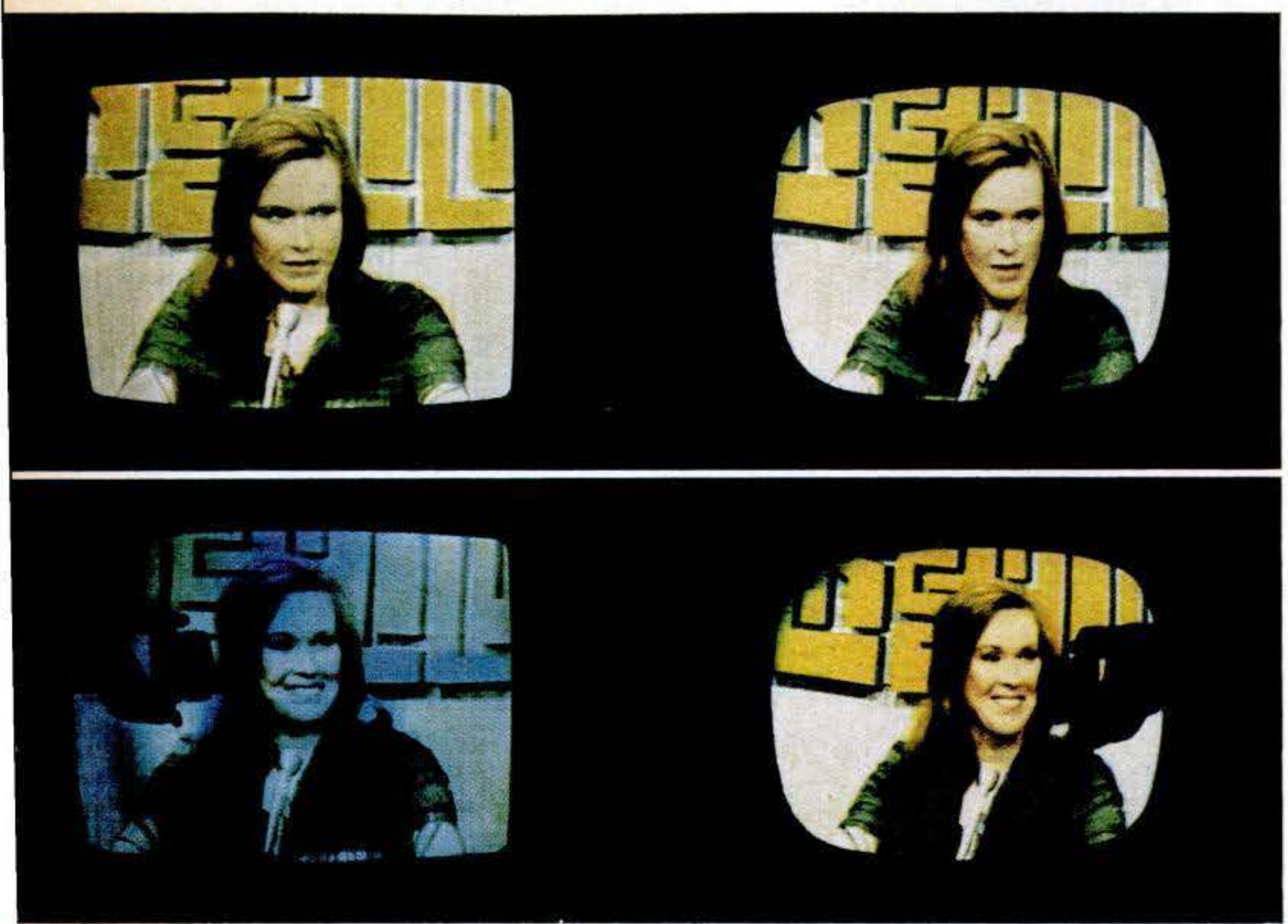
One industry expert I queried estimated that manufacturing savings—in both tube and chassis—could cut big-screen color-TV prices by as much as $100. Your service tabs will probably be lower, too—first, because periodic reconvergence (to eliminate color fringing in the image) isn't necessary; second, because the simpler chassis circuitry may be more reliable. And, of course, replacement picture tubes will be cheaper to buy and install—maybe as much as $75 less.

But, cost aside, Uniray has several other significant advantages:

- Because it has a single electron gun (to produce the single beam) and no precisely positioned shadow mask, the new tube is more rugged than conventional models. Sunstein told me that he has discussed using his tube in the cockpits of jet fighters for data displays.
- Because the tube is built very much like a black-and-white tube, it can be made shallower than conventional color picture tubes, so sets can be less bulky. The trick here is a wide-beam deflection angle (the angle the beam sweeps through as it moves across the screen). The standard big-screen color deflection angle is 90 degrees; it should be possible to design Uniray with the 114-degree angle used in black-and-white tubes.
- Because there's no shadow mask to absorb more than 80 percent of the total beam current, the beam that strikes the phosphors on the screen is very intense. Thus, the image is exceptionally bright. Sunstein's prototype tube was built in the mid '50s—using old phosphors—yet its picture brightness rivals the latest "ultra-bright" TV tubes made with high-efficiency phosphors. These same new phosphors in a Uniray tube would produce a picture more than twice as bright.

[Continued on page 140]

Comparison photos show Uniray's advantage



These side-by-side photographs, made simultaneously during a daytime broadcast, compare the Uniray tube (right photos) with a top-line 1972 set equipped with a superbright picture tube (left photos).

The top pair of photos shows a well-adjusted picture on each tube. The old-fashioned rounded-corner shape of the Uniray tube reflects the prototype's late-1950s heritage. And the somewhat different image coloring is caused by different phosphors. Bottom pair of photos contrasts the effect of a powerful magnet on each image. Note that the colors of the shadow-mask tube image (left) are mangled, while the Uniray picture is almost undisturbed.

How the Uniray and

The conventional shadow-mask color picture tube creates an image by illuminating hundreds of thousands of tiny colored phosphor dots on its screen. The scanning lines, caused by the sweep of the electron beams across the dot screen, are visible in the enlarged photo (middle right) of part of a complete picture. The extreme blowup (far right) shows the dot structure: Note that red, green, and blue phosphor dots are arranged in triads. Tiny dot size permits detailed, high-resolution images.

The Uniray tube creates an image that seems to be made out of tiny squares (see magnified portion, middle right). This is because a single scanning beam sweeps across a vertical array of phosphor stripes. The extreme blowup (far right) shows the structure of red, blue, and green phosphor stripes. Although the Uniray tube has been criticized by some engineers as having inferior resolution capabilities, note fine image detail in middle enlargement.

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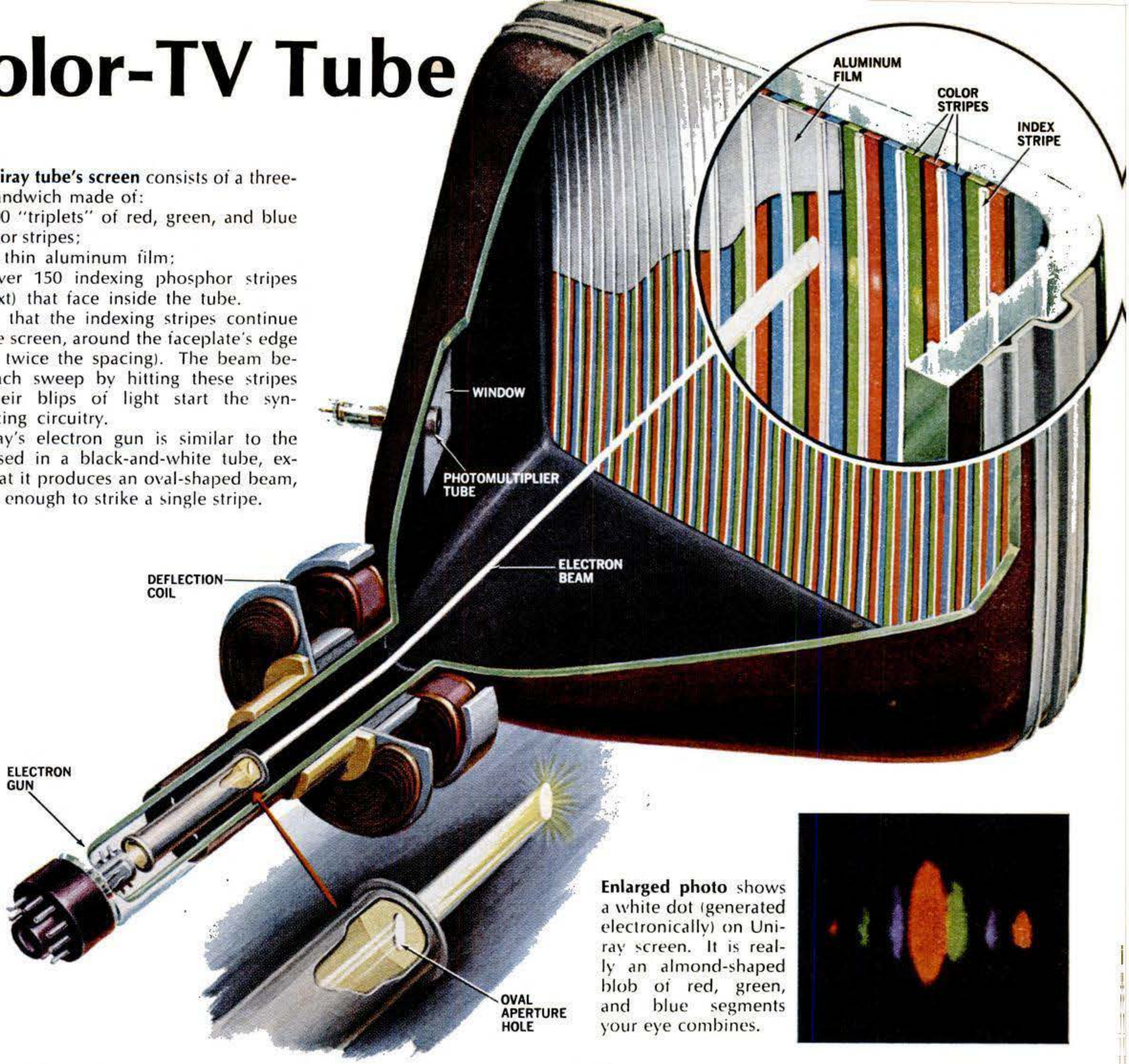
Color-TV Tube

The Uniray tube's screen consists of a three-layer sandwich made of:

- 300 "triplets" of red, green, and blue phosphor stripes;
- A thin aluminum film;
- Over 150 indexing phosphor stripes (see text) that face inside the tube.

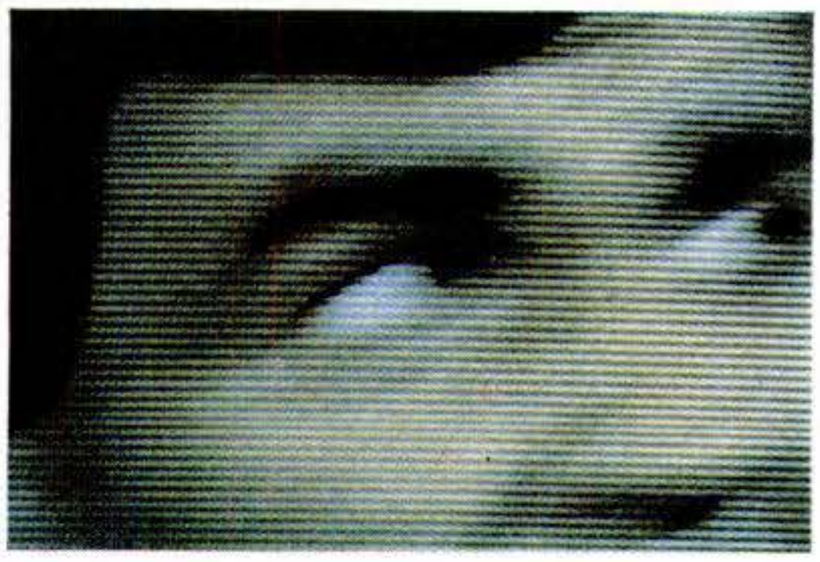
Note that the indexing stripes continue past the screen, around the faceplate's edge (but at twice the spacing). The beam begins each sweep by hitting these stripes first—their blips of light start the synchronizing circuitry.

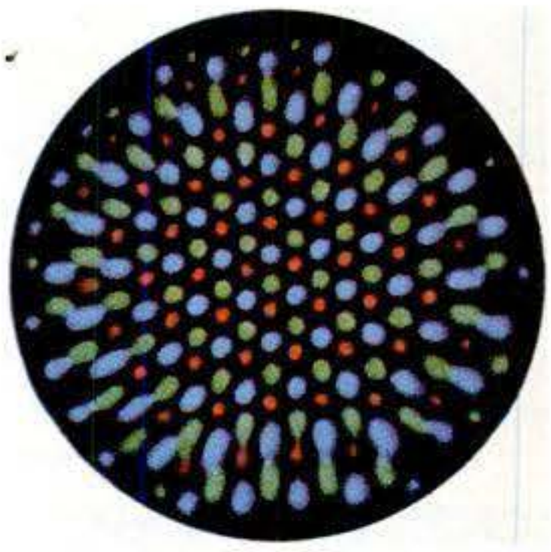
Uniray's electron gun is similar to the kind used in a black-and-white tube, except that it produces an oval-shaped beam, narrow enough to strike a single stripe.

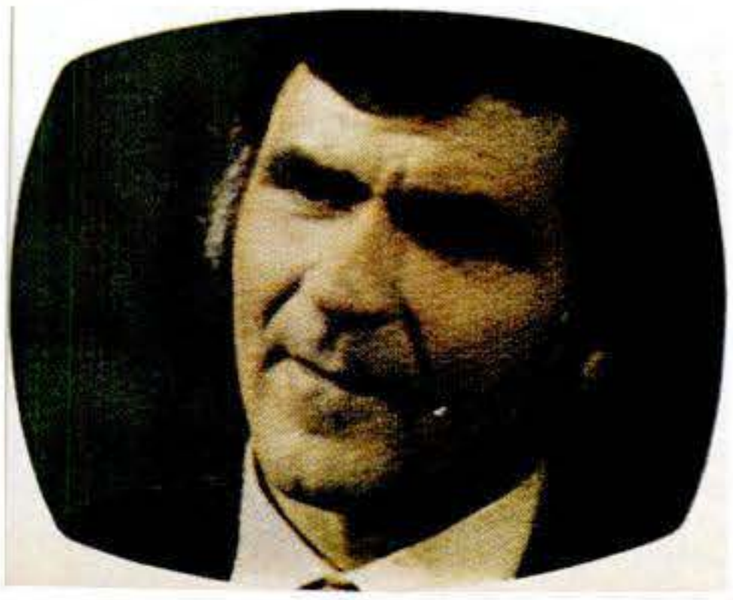


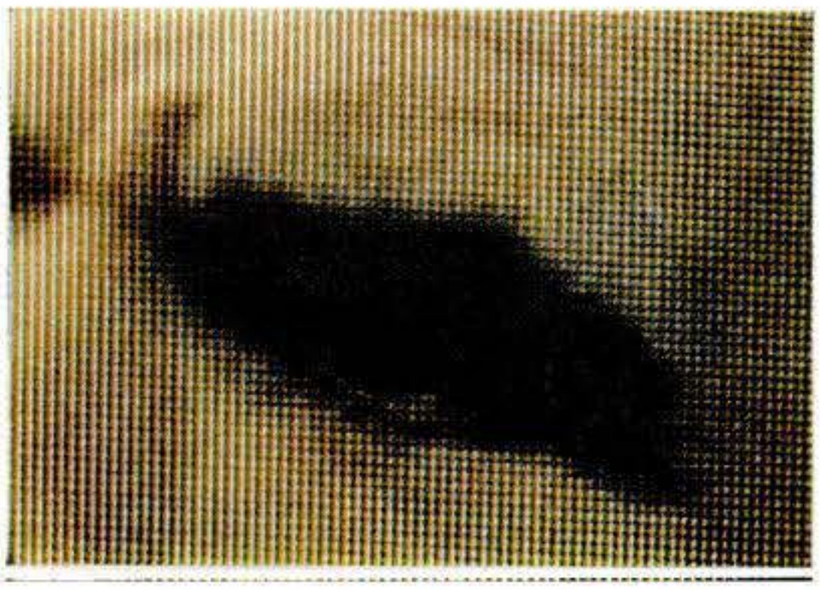
Enlarged photo shows a white dot (generated electronically) on Uniray screen. It is really an almond-shaped blob of red, green, and blue segments your eye combines.

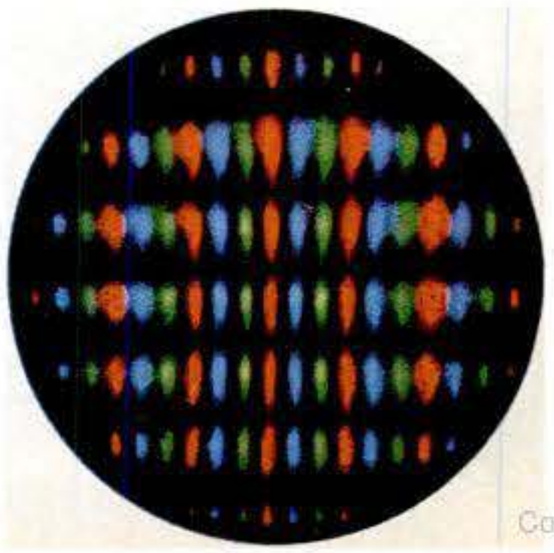
conventional shadow-mask color-TV tubes differ











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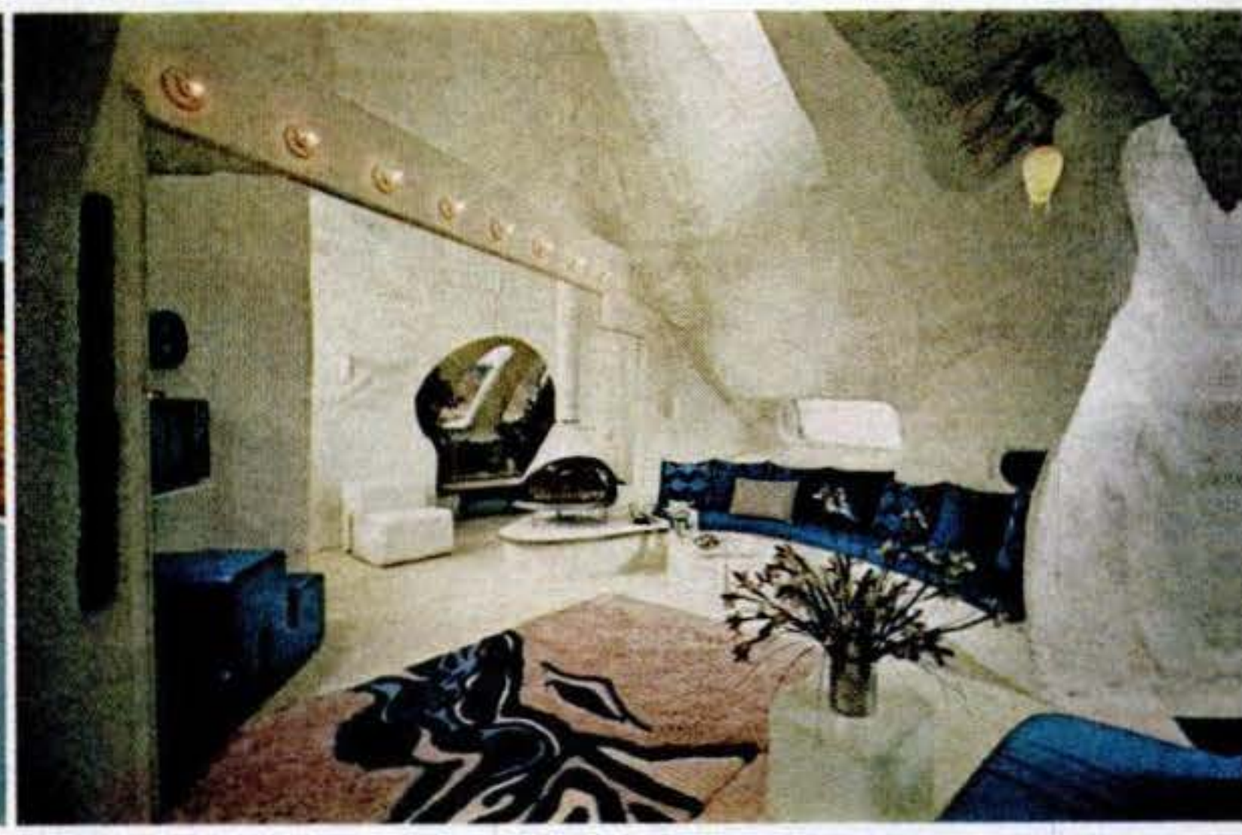
Geodesic dome at the San Diego Children's Zoo typifies continuing expansion of the eye-catching structures for public and commercial applications. Plywood construction—also popular in the booming dome-home field—lends to its structural integrity.

Urethane foam sprayed over heavy industrial nylon fabric forms the domes and connecting tunnels of WestPoint Pepperell's Foam House in Langdale, Ala. The technique simplifies styling.



Sunlight shines through molded-in plastic windows and Plexiglas-roof domes of Foam House, bouncing about the curved interior surfaces. The shiny Inmont foam texture contrasts with the fabrics.

Wood-shake shingles on this 26-ft. dome home in Felton, Calif., blend well with the surroundings. Shingling adds to dome cost but is effective way to prevent leakage—often a dome problem.

Preassembled pentas await assembly by crane in one of six 39-ft. domes comprising a San Jose preschool center. Geodesic Environments, a California dome firm, handled construction.

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The Great Dome Boom Is On

As building costs soar, dome homes gain on "square" housing

By RICHARD DAY
PS Consulting Editor, Home & Shop

Ever considered moving into a dome home?

Sold on their low cost, fast, easy assembly, and striking appearance, many people today are switching to domes from traditional "rectangular" living. Domes gained much of their momentum in counter-culture communes, where departure from conventional ticky-tacky house construction is favored. Now domes are mushrooming into suburbia, and gaining popularity as vacation housing and second homes.

Touring domedom throughout the country for the past year, I discovered why it's easy to become hooked on them. Once inside the eye-catching, mushroom-like structures, you're struck immediately by the vaulting dome interior. Your eyes follow the great-circle geodesic arcs from floor to apex. You study the gracefully repeated sweep of triangle arrangements. The sun pours in, the outdoors is all around, yet you're protected.

Gradual dome swell. After R. Buckminster (Bucky) Fuller patented the geodesic dome in 1954, little geodome movement occurred until Fuller licensed his design to be built by others. Early geodomes were erected for the military's arctic DEW line; next came large commercial structures, exhibition halls, and warehouses. Only recently have geodomes caught on as houses.

Fuller, Southern Illinois University professor, scientist, mathematician, philosopher, architect, engineer, inventor, and cartographer, created the geodome idea while working in experimental mathematics. He evolved what he calls "synergetic-energetic geometry," defined as "nature's own system of coordination based on triangles." The triangle, to Fuller, represents the "minimum self-stabilizing energy event."

Geodesic homes, with the highest strength per weight of any manmade structure, are formed by combining triangles into three-dimensional forms —often the 20-sided icosahedron (see box, page 69). Only a portion of the entire icosahedron forms the dome—usually five-eighths, one-half, or three-eighths. A half-dome, of course, is a hemisphere.

The cutoff can be made anywhere along the icoses—triangles of the spherical icosahedron that form the dome—providing whole triangles remain around the bottom to be fastened down. You can also add sections to stretch a geodesic dome into an oval. Equilateral triangles can be scrapped in favor of taller, slimmer isosceles triangles for egg-shaped domes.

Move to kits. A good share of the current dome boom is due to the growing number of dome-kit makers. Do-it-yourself kits trim costs about 40 percent over professionally built domes, and enable almost anyone to build a dome home. In Phoenix, Dyna-Dome's Billy Woods told me: "Very few of the people who build our dome kits are construction people. More often, they're artists, teachers, or something like that." Dyna-Dome kits have gone up in every state. Their 26-foot kit costs $1,060; the 49-footer sells for $3,770.

Under a giant 60-foot factory dome, I watched assembly-line production of Cathedralite Dome components for 26-, 39-, and 60-foot domes. Hand-fed saws quickly ripped standard two-by-fours to desired lengths and necessary edge angles. Laid in jigs, the shaped struts were glued and power-nailed with half-inch exterior plywood. Precut styrene foam insulation was pressed into the assembled triangles.

The earliest geodome kits were developed by Pease Woodwork, who now license the business to others. Three manufacturers of Pease Dome kits, Cadco of Plattsburg, N.Y., Price and Rutzebeck in Hayward, Calif., and Geodesic Manufacturing, Davison, Mich., formed the Geodesic Dome Manufacturer's Assn. GDMA, and others, are setting up dealerships and displays throughout the country.

Fast assembly. Prices vary, but a typical GDMA 26-foot-diameter vacation dome with some 530 square feet of ground-floor space, sells for about $1,700. The 39-foot house-size dome kits are double this cost.

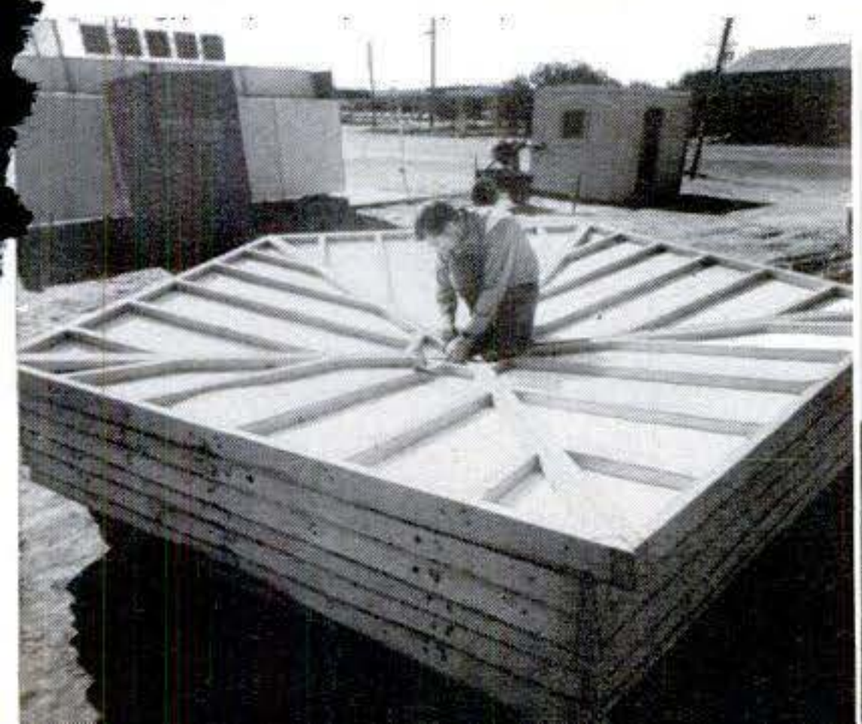
GDMA president Carlos McCarter estimates that once the foundation slab is ready it takes about 60 man-hours to erect a 26-foot dome, about 100 man-hours for a 39-foot dome. No skilled help is needed.

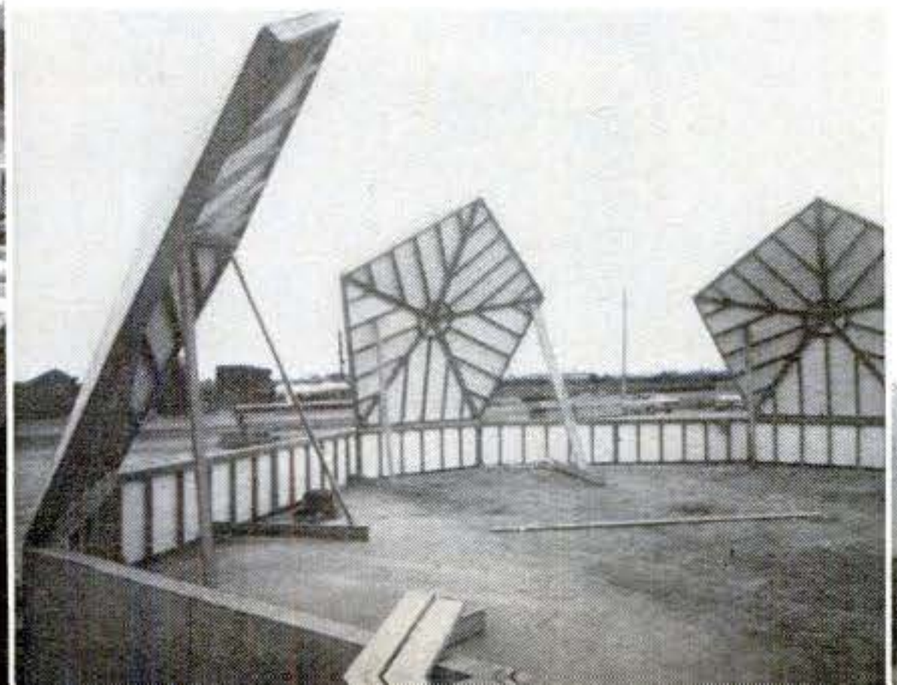
Insulation, hardboard interior paneling, windows and doors, utilities, and factory transportation are extra. Geodesic Environments furnishes a 39-foot, Pease-developed dome for $12,232 complete with trim, cabinets, heating and appliances.

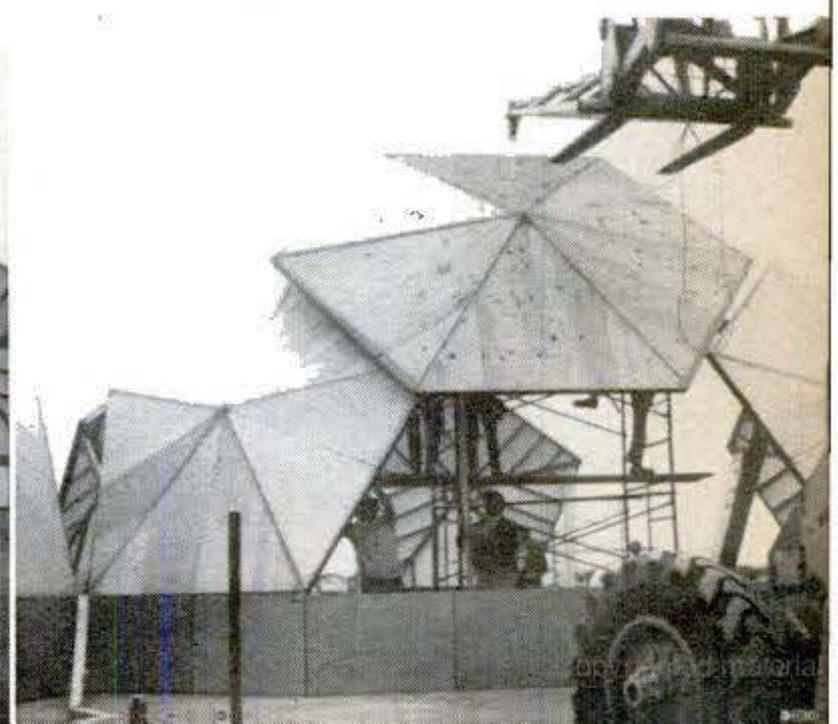
Dick York, Chicago-area writer, editor, and naturalist, hired a contractor to erect his 39-foot Geodesic Manufacturing dome out in the boonies "among the birds and trees." York's advice to would-be dome homeowners who contract their projects: Choose a contractor who is actually a dome-

Continued

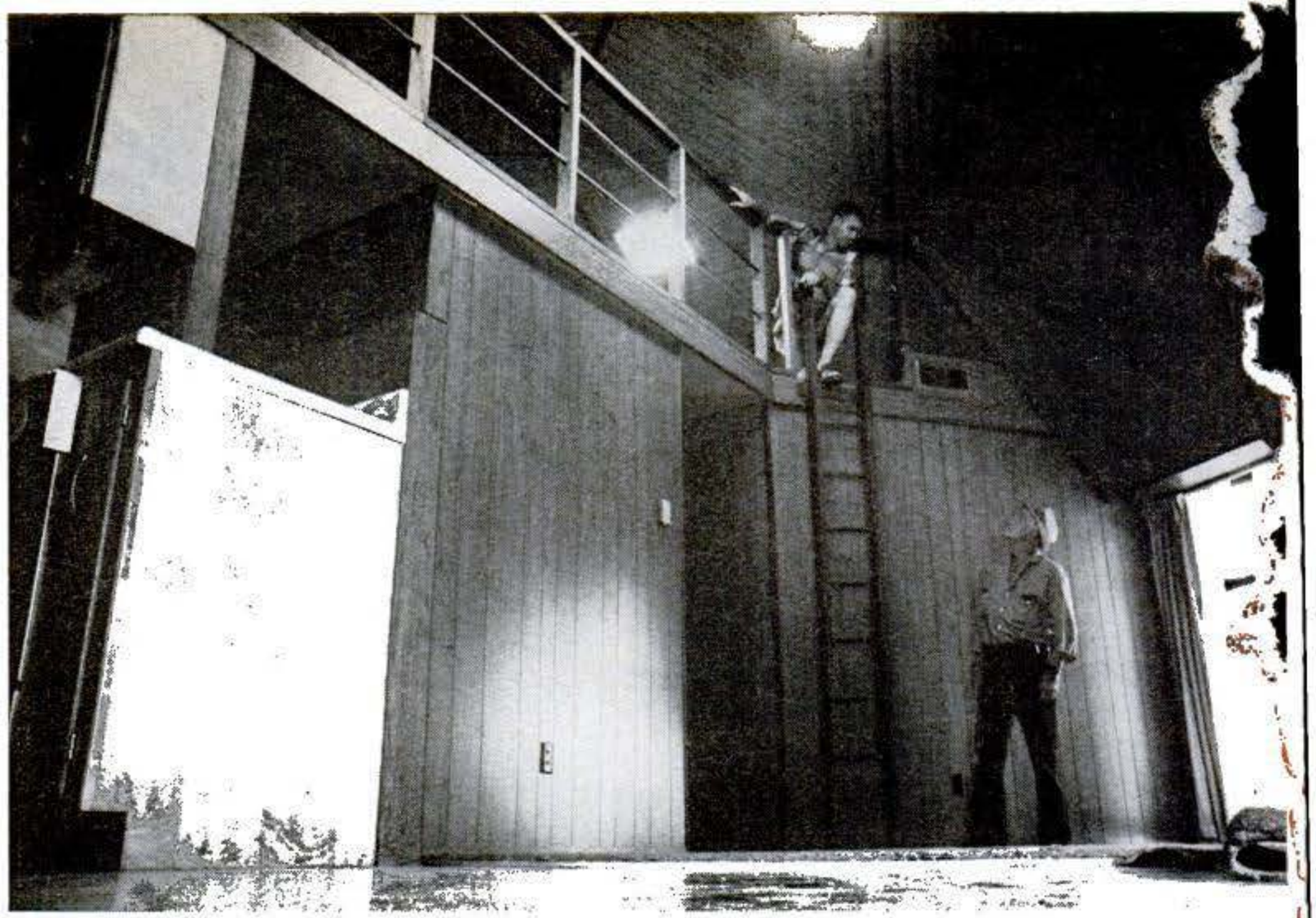
Dome takes shape below as professionals from Cathedralite start by assembling triangles on ground (left). Assembled pentagons are then propped into position and bolted to the knee-wall dome-raiser that adds height to structure (middle). A fork lift is used to set the second-row hexagons on pentagons for bolting (right). Doors and windows are framed after top is closed.







Atop a wood-framed dome during construction, builder's weight is distributed evenly to members of the geodesic.



Loft in this 39-ft. geodome home in Oroville, Calif., had to remain empty since building codes classified home as single-story. Some codes still restrict construction.

Tent dome set on Pacific coast hillside has vinyl skin inside the thinwall conduit frame. It's a 30-ft., four-frequency dome.

builder and will have the know-how.

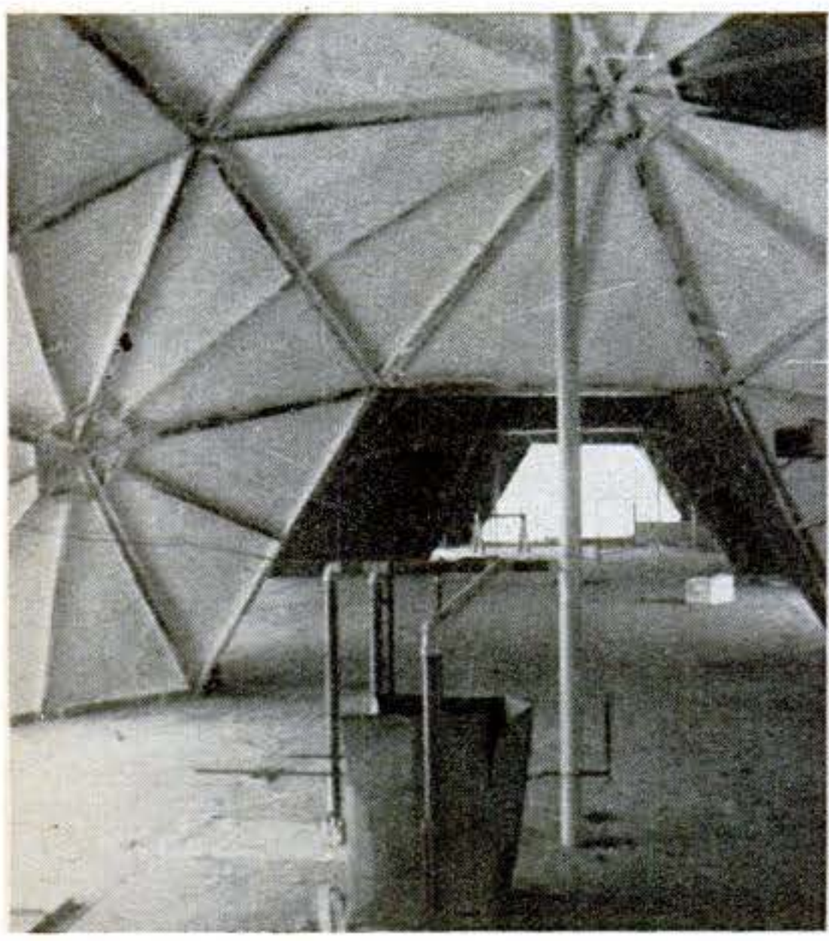
"Since the same shape is erected repeatedly, a dome goes up fast," says Lloyd Kahn, Pied Piper of domedom. His *Domebooks 1* and *2*, along with the PS Sun Dome presented in 1966, are prime movers of the dome boom. (The second *Domebook* is available from Random House, or Pacific Domes, Box 279, Bolines, Calif. 94924 for $4.)

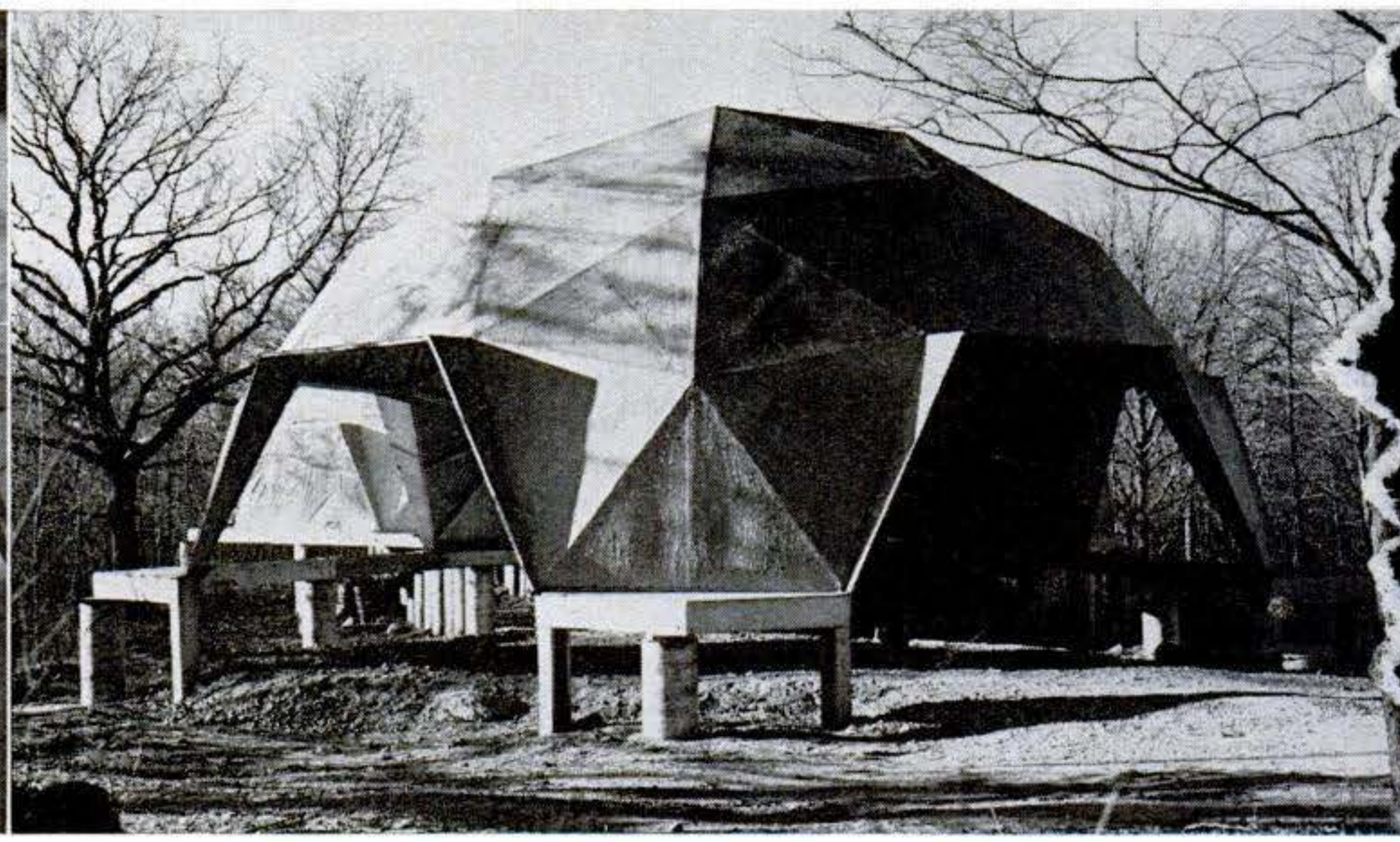
Concrete pumpkins. Developers are getting into the act, too. In Atlanta, Citizens and Southern Community Development Corp. is cooperating with a church to build two- and three-bedroom "flying-saucer" dome houses made of reinforced concrete cast in lightweight fiberglass forms. The flattened-pumpkin-shape homes offer 1,000 square feet of floorspace for about $14,000.

Domebuilding material usually dictates the system of construction. Materials used so far: plywood, sheet metal, sandwich panel, ferrocement, vinyl pillows, foamed-in-place plastic, and various scrap materials such as car tops.

Lloyd Kahn, who likes plywood, also feels sheet metal has many possibilities. For a sheet-metal dome I inspected in Northern California, aluminum sheets were broken two ways across each triangle. It had a clean, tight look—fireproof, too. Thermal expansion of sheet metal, however, can be a problem.

Plastics may be on the way out for dome-home construction. Pacific





Roomy interior of Chicago architect Lawrence Harrison's four-dome is suggested in shot above. The 39-ft. domes are set atop a plywood platform on concrete columns in a 20-acre wooded suburban site. One dome will be the garage; another, attached to it, will become Harrison's studio. A third dome in the string is living, dining, kitchen area; the fourth will be bedrooms, bath, and laundry. Plumbing and other utilities feed from below deck. A heat-pump air-conditioning system is in a concrete-block enclosure under the living unit. Harrison works weekends on the house with his daughter Barbara and son Peter, both college students.

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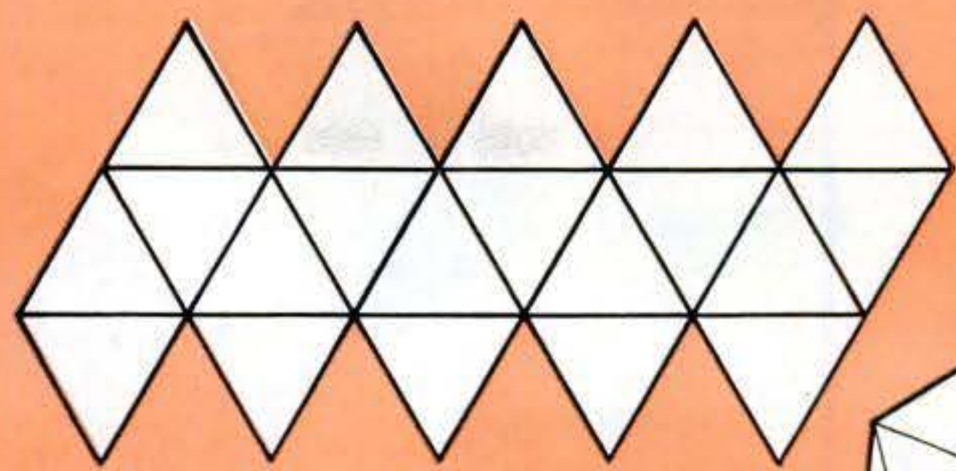
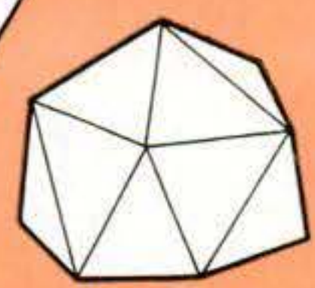
How to experiment with geodesic geometry in your home

Demonstrate the basics of geodesics for yourself, draw 20 equilateral triangles on heavy paper. Then fold and glue them into a 20-sided icosahedron. You'll find the icosahedron is rigid, even with flimsy glued joints. Now cut off the five bottom triangles and place your home-made model dome on a table. Although it sits flat, it's unstable because of the removed triangles. When anchored to tabletop with tape, however, it again becomes stable. For large-scale domes, huge triangles couldn't be handled without equipment. But the triangles can be broken down by projecting the icosahedron into a sphere. Each triangle in the spherical icosahedron is termed an icosa; these are subdivided into smaller triangles. With two subdivisions on each edge, you generate a two-frequency structure; three subdivisions generate a three-frequency structure, etc. Dome becomes more spherical as number of facets increases. You can find further details on geodesic geometry and construction in Pacific Dome's popular "Domebook 2."

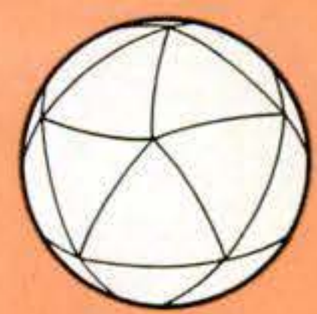


20 Equilateral triangles

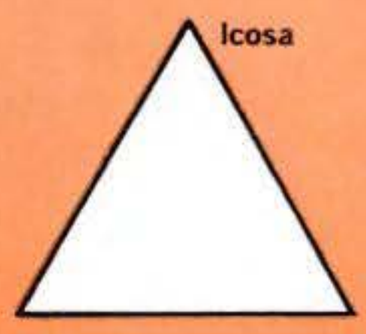
20-Sided icosahedron



Dome model



Spherical icosahedron



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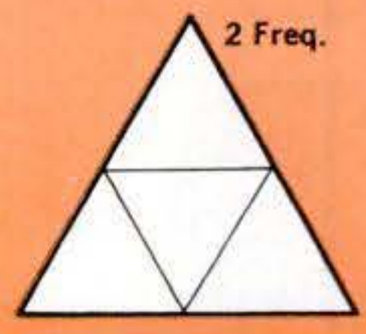

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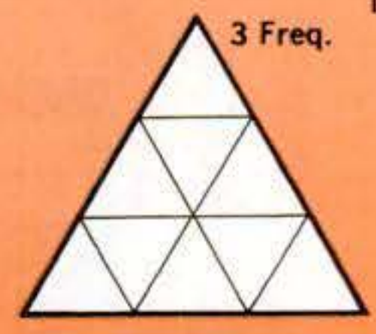


3 Freq.

Domes receives thousands of letters describing problems with plastic: leakage, moisture condensation, static buildup, and wind damage. Foamed urethane makes an attractive, self-insulating dome, but requires professional application and has a low resistance to fire. One such dome in Vancouver, B.C., burned to the ground in five minutes.

Plywood is the most widely used dome material. "It has structural integrity that no other material can provide," says Woods. A Dyna-Dome's plywood covering will support 40 pounds per square foot. With the framing, it will support a 60-psf load, double average roof-design requirements, according to Woods.

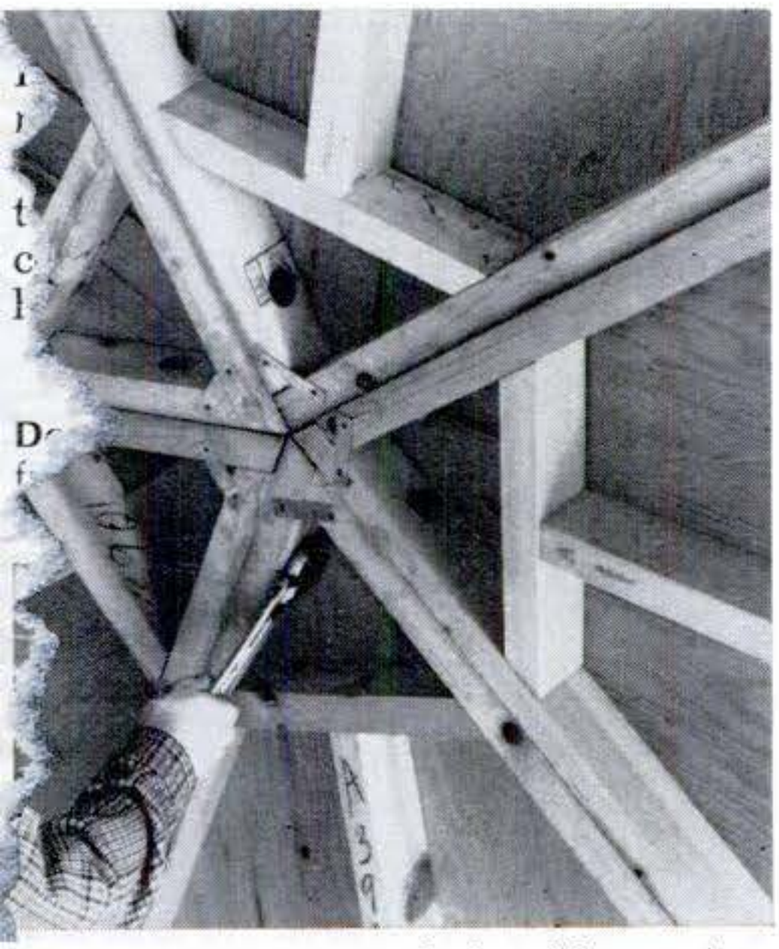
Architect Edward G. Grafton, chairman of the AIA's low-income housing committee, is one of the detractors of the geodome. They're not the answer to low-income housing, he feels. Admitting domes cost about a third of the going rate for houses, he says: "That's just the skin you're talking about. The real money in a residence is in the internal systems, not the structures. So you're just talking about cutting two-thirds off the 20 per cent invested in the skin."

Although dome experts would disagree, Grafton says of the geodome: "It's not functional, it can't stand solar loads, it won't stand up in high winds, and you can't build them easily out of concrete."

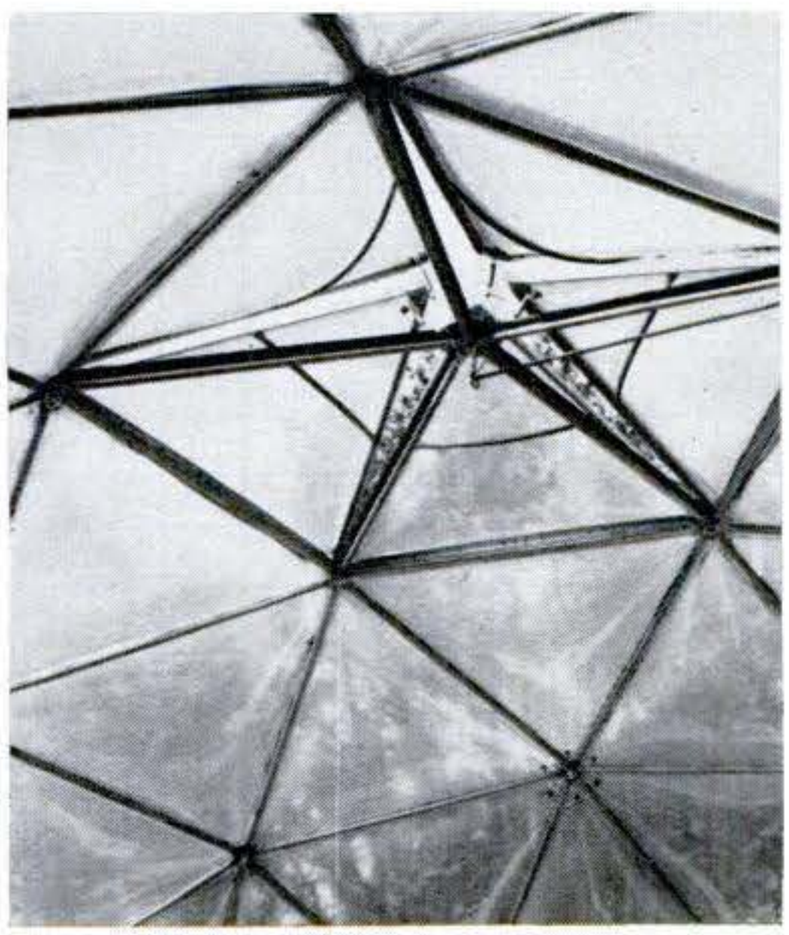
One deterrent to dome expansion is the building-trade unions in highly unionized areas like New York and Chicago. "Guys off the street can come in and build domes," says one dome builder, "and the unions naturally don't like it."

A much stronger deterrent is local building codes. Unless the dome design is one that has already won national code acceptance through extensive engineering—such as GDMA domes—they may not be acceptable in your community without hard-to-obtain code modifications.

Part of the code problem is the age-old prejudice against anything out of the ordinary. "The code-writing people are used to 90-degree architecture," says one expert. "They understand it. But 60-degree architecture is new to them." PS



Harrison puts costs, including labor, at $10-$12 a square foot—half that of comparable squared-off construction. Photo here shows how wood triangles combine to make dome's pentagons and octagons.



Nitrogen-filled vinyl pillows fastened to thinwall conduit structure make this an unusual tent dome. Triangular vents in center pentagon open with a cord-operated lever. The pillows insulate the dome.

Want plans to build your own dome?

You can get them from the Popular Science Plans Division.

Ever since 1966 builders have been using Popular Science Sundome plans to put up their own geodesic domes. These plans were first presented as a means of providing a shelter over above-ground circular swimming pools. The dome is built of two simple components—thin wood strips and sheet polyethylene or vinyl. The strips are assembled into triangular frames and the plastic sheet is stapled to the frames. These triangular units are finally stapled together into a surprisingly strong structure.

This PS plan costs $5. Send check or money order to Popular Science Plans Division, 355 Lexington Ave., New York, N.Y. 10017 and ask for Sundome Plan No. 5519.

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PS Buyer's

Self-contained "electronic notebooks" record your thoughts anywhere. Photo doesn't show all units listed below.

MINI-RECORDER FACTS & FIGURES	PRICE	SIZE (in.) W-H-D	BATTERIES/ NI-CAD	AC ADAPTER/ CHARGER	WEIGHT (lbs.)	RECORD LEVEL/ BATT. METER	AUTO-LEVEL CONTROL	AUX. MIKE	CASE	MIKE TYPE	DIGITAL COUNTER	TRANSCRIBER AVAILABLE	FAST FWD	EARPHONE	TAPE
BELL & HOWELL 3095K	**$ 89.95**	**10 x 2¾ x 8½**	**4C/NO**	**YES/NO**	**5.2**	**YES**	**YES[2]**	**YES**	**NO**	**DYN.**	**NO**	**NO**	**YES**	**YES**	**C**
CONCORD F-26	74.95	4 7/16 x 7½ x 2 3/16	3C/NO	YES/NO	2.5	YES	YES[2]	NO	NO	COND.	NO	NO	YES	NO	C
CRAIG 2605 (e)	**119.95**	**3½ x 5½ x 1⅜**	**3AA/OPT.**	**OPT.**	**1.7**	**NO**	**YES**	**YES**	**YES**	**COND.**	**YES**	**YES**	**YES**	**YES**	**C**
DeJUR/GRUNDIG MARK 8 (f)	89.50	2 7/16 x 6½ x 1 7/16	3AA/NO	NO	0.8	YES[3]	YES	OPT.	NO	DYN.[4]	NO	YES	NO	OPT.	SC
DICTAPHONE 10	**99.00**	**2½ x 5 x 1**	**9V/NO**	**NO**	**0.6**	**NO**	**YES**	**OPT.**	**NO**	**DYN.[4]**	**NO**	**YES**	**NO**	**OPT.**	**MC**
FI-CORD 300A (o)	229.95	3¼ x 6⅜ x 1⅝	3AA/NO	OPT./NO	1.3	NO	YES	OPT.	NO	DYN.[4]	YES	YES	YES	NO	RR
GE M8700 (a)	**89.95**	**3½ x 6⅛ x 1½**	**5AA/NO**	**OPT./NO**	**1.7**	**NO**	**YES**	**OPT.**	**YES**	**COND.**	**NO**	**NO**	**YES**	**OPT.**	**C**
GRAY LP/D (l)	239.00	3½ x 7½ x 1¾	4C/NO	OPT./NO	2	YES	YES	YES	YES	XTAL	NO	YES	YES	OPT.	C
HITACHI TRQ20 (b)	**99.95**	**3½ x 5½ x 1⅜**	**4AA/NO**	**YES/NO**	**1.1**	**NO**	**YES**	**YES**	**YES**	**DYN.**	**NO**	**NO**	**YES**	**YES**	**C**
IBM 274 (n)	425.00	4¾ x 6⅛ x 1¾	IBM (1)	NO	1.7	NO/YES	NO	OPT.	OPT.	DYN.	NO	NO	YES	OPT.	B
MEMOCORD K-70 (j)	**159.50**	**3 x 5¾ x 1**	**3AA/NO**	**NO**	**0.8**	**NO**	**NO**	**OPT.**	**YES**	**DYN.[4]**	**NO**	**YES**	**NO**	**OPT.**	**SC**
MERCURY 20-9010 (g)	89.95	3 11/16 x 6 11/16 x 1 15/16	4AA/OPT.	OPT./YES	1.8	NO/YES	YES	YES	NO	DYN.[4]	YES	NO	YES	YES	C
NORELCO 85 (h)	**99.00**	**2⅝ x 4¾ x 1⅜**	**9V/NO**	**NO**	**0.7**	**NO[2]**	**YES**	**OPT.**	**NO**	**DYN.[4]**	**NO**	**YES**	**NO**	**OPT.**	**MC**
PANASONIC RQ-222AS (m)	99.95	9⅛ x 5⅛ x 1⅞	4C/NO	YES/NO	3	YES	YES	OPT.	YES	COND.	YES	NO	YES	YES	C
ROBERTS 111 (k)	**79.95**	**4 x 6½ x 1⅝**	**4AA/OPT.**	**YES**	**1.7**	**YES**	**YES**	**OPT.**	**YES**	**COND.**	**NO**	**NO**	**YES**	**YES**	**C**
SHARP RD-428U	79.95	4 11/64 x 6 7/32 x 1 11/16	4AA/YES	YES	1.7	YES	YES	OPT.	NO	COND.	NO	NO	YES	YES	C
SONY TC40 (d)	**99.95**	**4⅜ x 7 x 1 15/16**	**4AA/OPT.**	**OPT.**	**1.7**	**YES**	**YES**	**OPT.**	**YES**	**COND.**	**NO**	**NO**	**NO[2]**	**YES**	**C**
TOSHIBA KT-202	69.95	10⅞ x 2¾ x 8½	4C/NO	YES/NO	5.2	YES	YES	YES	NO	DYN.	YES	NO	YES	NO	C
WESTINGHOUSE TMC2025 (l)	**69.95**	**3⅞ x 6 x 1¾**	**4AA/OPT.**	**YES**	**1.6**	**YES**	**NO**	**YES**	**YES**	**DYN.**	**NO**	**NO**	**YES**	**OPT.**	**C**
WOLLENSAK 400 (c)	99.95	3¾ x 6⅝ x 1⅝	4AA/OPT.	YES/YES	1.6	YES	YES	YES	YES	COND.	NO	YES	YES	YES	C

NOTES: 1—battery-warning light. 2—see text. 3—battery level only. 4—speaker/microphone. C: Philips-type standard cassette; SC: special tape cassette or cartridge; MC: Philips mini-cassette; RR: reel-to-reel; B: belt; DYN: dynamic mike; COND — condenser mike; XTAL — crystal mike. A NO for nickel-cadmium batteries means they are not offered by the manufacturer; you may be able to obtain them from other sources.

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Go-anyplace mini-recorders with built-in mikes take the hassle out of tape recording

Guide to Pocket Tape Recorders

By JOHN R. FREE

A new generation of ultracompact, self-contained tape recorders is here. Philips' introduction of matchbook-size mini-cassettes, and condensed features on standard-cassette machines are responsible. Best news—whether you tape sounds of family and friends, record lectures and meetings, or just make electronic memos to yourself—are the new units' built-in microphones.

Dangling cords—or a mike left behind in the glove compartment—needn't be a problem any longer. Everything's there in one pocket-size recorder. You're less likely to encounter "lockjaw" from mike-shy subjects; no one even has to know you're recording. New supersensitive, button-size, built-in condenser mikes, feeding automatic-level-control circuits, can "grab" a whisper across the room and freeze it on tape.

We collected the smallest built-in-mike recorders on the market and used them for a month. Some of the dictating units, paired with optional office transcribers, have been available for years. Others, like the Dictaphone 10, just entered the market. Also used, since they had built-in mikes, were two larger "desk-top" portables (Toshiba, Bell & Howell).

Prices ranged from a low of $70 to a walloping $425 (IBM's 274). Since pocket recorders are primarily intended for voice-quality reproduction, only obvious differences in playback quality were noted. Generally, you can expect audio quality similar to portable radios with comparable speakers. You could take prerecorded music cassettes (stereo or mono) to the beach, for example, and hear acceptable sound.

Overall, none of the 20 units stood out; there was a fascinating mix of useful features, but no one unit possessed them all. Let's take a recording tour—from power sources to tape playback—to find out what these machines can do.

First, how are the units powered? From the chart, you'll note many use AA penlight cells. More accurately, they *devour* penlight cells! Two hours of battery life from carbon-zinc cells is not uncommon with standard-cassette recorders like Sony's TC-40. An exception is DeJur/Grundig's Mark 8 (cartridge), which coaxes 15 hours from three carbon-zinc AA cells. Alkaline or mercury cells boost your recording time. The Memocord 70 runs 15-25 hours on three AA alkaline cells. Larger C cells may power machines some three times longer than penlight cells. The two mini-cassette players (Dictaphone 10, Norelco 85) operate from widely available nine-volt "transistor" batteries.

Rechargeable nickel-cadmium batteries are your best bet for pocket recorders. They can run recorders for hundreds of hours. Manufacturers often provide ni-cad chargers and cells as an optional accessory, or include the charger with the machine (minus ni-cad cells).

A few units have battery-recharging circuits built in. Sony offers a combination AC adapter/charger for their TC-40. A sealed ni-cad battery pack replaces the snap-in penlight-cell pack; the adapter's six-volt output gives batteries a rest or recharges the ni-cads. AC adapters save you a lot of batteries.

How do you know when your batteries are low? Most recorders have a small meter that shows battery strength in the playback mode. The meter usually doubles as a record-level indicator.

On Craig's 2605, though, a tiny battery lamp comes on when 5-10 minutes of battery life remain. GE's recorder has a pushbutton that flashes a small red light, while the Memocord lights become dimmer. When you push a switch on Norelco's 85, an AC signal is fed to the amplifier; you won't hear the dial-tone buzz if the batteries are too low.

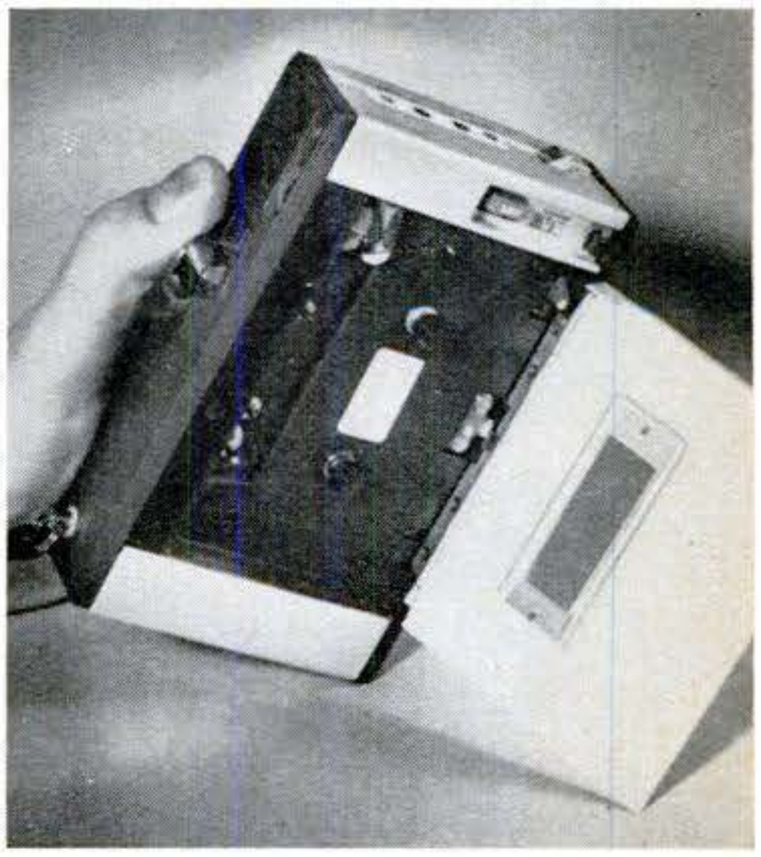
Now you're ready for tape. You slide the covers back on the two mini-cassette units. Unlike their larger standard-cassette cousins, the minis don't use a capstan drive; instead, the takeup reel pulls up to 15 minutes (one way) of nine-micrometer-thin tape past the head.

Standard cassettes load easily, but require some manipulation to align guide pins. Slot-loading, push-down covers (on the Roberts and Sharp units, for example) eliminate even this problem, making cassette loading a one-hand operation. The DeJur/Grundig cartridge and Memocord index cassette are slot-loaded, while IBM's tape belt is formed into a figure

Continued

Ultracompact units like this Dictaphone 10 and the Norelco 85 fit in your shirt pocket. Both recorders use new mini-cassettes.

Philips' mini-cassette is shown with their standard cassette, made under license throughout world. Mini records 30 minutes.



Chock-full of useful features and latest electronics, Craig's 2605 is typical of coat-pocket-size cassette units now available.

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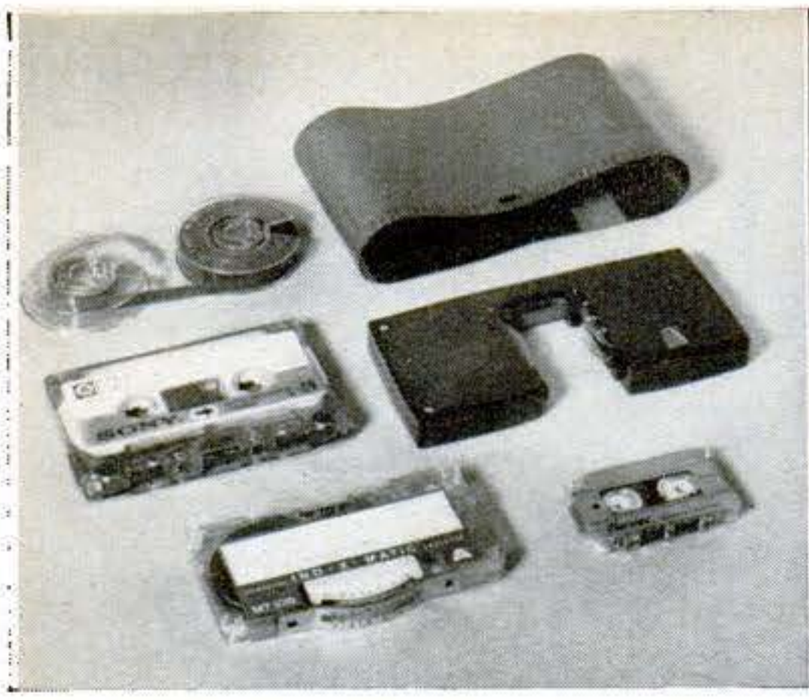

Tape formats: Fi-Cord reel, IBM belt (top); Philips cassette, DeJur/Grundig cartridge (middle); Memocord cassette, mini-cassette.

You press the top of Memocord's slot-load index cassette to record, press bottom to rewind. Cassette pointer indexes tape used.

8 and slipped on. The Swiss-made Fi-Cord uses reel-to-reel tape.

All set to record? On the pocket-size, standard-cassette recorders, you hold down a button with one finger while pushing the record switch. With the mini-cassette units, all the operating controls are under your thumb, making them very convenient to use. The other machines that don't use standard cassettes have similar one-switch operation.

Now tap the built-in mike cover with your finger. If the recorder has a record-level meter, it should jump. This indicates a signal is getting through most of the circuitry. Without a meter, you should record a few words, rewind the tape, and play them back to insure that the recorder is operating.

While you're recording, if the machine has a digital counter, it's a good idea to make notes and log the numbers for sections you may want to find quickly later. The Gray and IBM machines have tiny pens that travel over a strip of paper as you record—primarily to indicate length of dictation for someone transcribing the tape. You mark the strip at the end of a letter by pressing on the marker tip.

A fast search for specific sections on tape, incidentally, is greatly aided by a fast-forward feature. Otherwise, with cassettes, you must remove the cassette from the recorder and reverse it. Pushing the CUE button on Sony's TC-40 doubles the playback speed, but it's not a true fast forward.

Automatic level control (ALC) takes care of changes in input-signal levels (people moving around a room) on most of the recorders. Three of the machines (B&H, Concord, Memocord) have an ALC-defeat switch so you can vary mike sensitivity manually. ALC can also cause problems, but there are techniques for avoiding them (see section below).

Built-in alarms. If you're in the record mode when the tape runs out, several recorders let you know it. Sony's TC-40 was the only standard-cassette machine with a buzzer alarm. The Dictaphone 10 also squeals when a mini-cassette runs out of tape. The Memocord uses a small light. The Panasonic automatically shuts itself off, disengaging the pinch roller. Toshiba's 202 has an automatic-shutoff feature, too.

You're ready for playback after you've rewound the tape. None of the recorders delivered unacceptable voice recordings, although the Westinghouse machine picked up an annoying amount of motor noise. As you'd expect, the units with combination mike/speakers had poorer fidelity. The compact mini-cassette machines, for example, are designed to reproduce a narrow slice of the audio spectrum (around 1,000 Hz) covering the human voice.

Although they're meant for office use, the transcribers available with several recorders generally have larger speakers. The two larger "desktop," standard-cassette machines provided the best fidelity due to their larger speakers.

All of the machines had facilities for plugging in accessory mikes and telephone pickups. Undoubtedly the most complete package is the Wollensak 400, which includes everything you need for recording: phone pickup, charger, AC adapter, external mike. A cobalt-energized cassette—a good way to eliminate hiss with any standard-cassette machine—is included.

You're likely to see more mini-cassette machines coming on the market. They're easily the most convenient to use and carry with you. Their limitation, of course, is a 30-minute recording time.

Here's where you can write for further information on some of the machines: DeJur/Grundig: DeJur-Amsco Corp., Northern Blvd. at 45th, Long Island City, N.Y. 11101; Dictaphone Corp., 120 Old Post Rd., Rye, N.Y. 10580; Fi-Cord: Karl Heitz Import Co., 979 Third Ave., New York, N.Y.; Gray: Lanier Business Products, Box 1555, Atlanta, Ga. 30301; Mercury: Pax, Ltd., 5125 Church St., Skokie, Ill. 60076; Memocord: 78 E. Palisade Ave., Box 252, Englewood, N. J. 07631. PS

Techniques to improve your tape recordings and avoid tape damage

Trouble making a decent recording? You're not alone. Despite the operating ease of the newer mini-recorders, some people are all thumbs when it comes to getting their thoughts—and those of others—on tape. A few tips that may help you:

- If you're using cassettes—especially the thin-tape C-90s and C-120s for long play—buy only well-made, quality units. Avoid the cheapies. Long-play cassettes are more prone to snarls and breakage.
- For repeated playing of thin-tape cassettes, try rapping them gently on a tabletop (photo). This may help loosen tape wound too tightly—and thus prevent snarling.
- Get in the habit of glancing at the tape reels when you throw the record lever. You may have a reassuring "jump" on your record meter when you talk into the mike, but if the tape mechanism is jammed you'll record zero.
- Don't use the built-in mike to record where ambient noise is high. Automatic level controls can't differentiate between noisy machines in the background and a voice. Switch to a plug-in mike; hold it close to the desired sound source. Don't place the recorder on a vibration source—on refrigerators, near fans, etc.
- Always remove batteries from a recorder if it's unused for some time. A Norelco service manager told me many machines in for repair are badly damaged by leaking carbon-zinc cells.
- Clean the record/play head frequently with alcohol and a cotton swab. Also remove oxide deposits from pinch rollers, capstan shaft, and tape guides.
- Demagnetize the head often, to prevent residual-magnetism buildup. Use a hand-held demagnetizer with its tip protected by tape or plastic to avoid scratching the recorder head. Residual magnetism will add to normal background tape hiss, and could ruin prerecorded tapes by adding unwanted hiss to the music.

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Test of neural efficiency is administered to author Wahl by Dr. John Ertl, inventor of the analyzer. Electrodes in copper-sheathed helmet pick up brain's electrical responses to flashing light.

Analyzer reads out elapsed time in milliseconds between onset of light and two different kinds of brain-wave response. The lower the number, the better the score. Scores correlate well with IQ and ability to do well in school and career.

Can Your Brain Waves Reveal Your IQ?

This new tester can tell just how quick-witted you are —in only a few minutes

By PAUL WAHL

There I was, sitting in a darkened room and staring at a blinking light, having my brain efficiency tested by a computer.

Called the *Neural Efficiency Analyzer*, this instrument does not measure intelligence, but rather the ability to learn, as indicated by the efficiency (speed) of information transmission within the brain.

Research has established that some aspects of the human brain's electrical activity (brain waves) are related to intelligence. Sensory stimulation—such as a flashing light—causes non-random change (evoked response) in this electrical activity.

The Neural Efficiency Analyzer computes the average time delay between the onset of the stimulus and each of two particular electrical responses of the brain. Readout—the neural efficiency "score"—is the average time in milliseconds. Thus, the lower the number you score, the higher your neural efficiency.

A normal score is between 120 and 140. The highest neural efficiency recorded to date is an average time of 85 milliseconds, scored by a subject with an IQ of 186 (a belly dancer who speaks 10 languages).

Tests of thousands of children and adults reveal a significant correlation between neural efficiency and intelligence quotient. There is ample evidence that high neural efficiency is a factor in high intelligence.

During the test, I wore a special helmet—copper-shielded against electrical interference—with a pair of electrodes touching my scalp and a ground wire clipped to my right earlobe. A cable connects the electrode helmet—via an EEG amplifier (to boost the weak brain-wave signal)—to a computer.

Nearby, a small oscilloscope monitored my brain waves, showing them marching in blips across its green screen. This monitor oscilloscope permits the operator to determine whether good quality EEG is present before starting the test. Also in the hookup is the photic stimulator (flashing light). Synchronized with the subject's brain-wave responses, the light flashes at random intervals of from one-half to 1½ seconds.

The operator pressed a button on the computer to start the completely automatic test procedure. While I looked at the light, it flashed 200 times (the standard number of stimuli for neural efficiency analysis) before I was informed that the test was over and I had scored 90. Altogether, it had taken about five minutes.

Incidentally, this procedure is entirely safe. There is no electrical hazard—the voltages involved are very low.

Now in production after a dozen years of research and development, the Neural Efficiency Analyzer is the invention of Dr. John Ertl, Director of the Center of Cybernetic Studies at the University of Ottawa.

Dr. Ertl also is Vice President and Director of Research of Neurometrics, Inc., a subsidiary of Associates International, Inc., the Shreveport, La., firm marketing the Analyzer. The equipment is available, on lease, to psychologists and other qualified professionals.

Someday, this five-minute electronic test of the ability to learn may be in general use in our schools—perhaps even replacing traditional pencil-and-paper IQ tests. Unlike standard intelligence tests with their built-in cultural bias, the Neural Efficiency Analyzer doesn't penalize so-called "culturally deprived" children. The subject doesn't have to read, write, or even speak to take this test, which also makes it ideal for testing handicapped persons. PS

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SPACE-AGE DOGFIGHTING—

It's a Wild New

Instinct? Not at the Air Force's dogfight school. The planes are too fast, and the stakes are too high

By KEVIN V. BROWN

Trying to look unconcerned, author sits in cockpit of F-106 at the Air Force dogfight school, awaiting action.

Briefing by Maj. Ed Woelfel (left), Operations Officer, preceded training mission.

Brown is fitted for helmet and oxygen mask. Instructor demonstrates test for leaks.

Takeoff: That's Woelfel in forward cockpit of F-106, in photo taken by the author.

Major Ed Woelfel held some of my equipment while I climbed the ladder and squeezed my middle-aged bones into the cramped rear cockpit of the F-106 Delta Dart, a supersonic fighter that is the backbone of the United States Air Force's Aerospace Defense Command.

He followed me, and helped get me strapped in and hooked up—parachute, survival gear, shoulder harness, seat belt, and finally the life-support and electronic equipment—oxygen mask, radio, and g-suit, which, like cowboy chaps, was wrapped around my midsection and legs. Working from the engine compressor, it would inflate during high-g maneuvers to prevent blood from pooling in my lower body, draining the brain of oxygen and causing blackouts.

Ed leaned over and pulled the safety pin from the seat-ejection handle. "In case we have to bail out," he explained, "just pull up on the handle. That will blow the canopy. You'll rocket out, and the chute will open automatically." He climbed down the ladder, leaving me alone with my thoughts about how much had changed since my fighter-pilot days back in World War II. We wore parachutes, of course, and shoulder harnesses and seat belts, and used oxygen and radio equipment, but g-suits were unheard of and ejection seats unthinkable. We just rolled it over and got out as best we could.

And the planes! With our old propeller-driven fighters we did well to get over 400 miles per hour in a dive. Today's fighters, with their big jet engines, can do anywhere from 1,400 to 2,000 mph *straight and level!*

And the firepower! We used .50-caliber machine guns, which had to be aimed manually, and it took a lot of hits to destroy an enemy aircraft. The F-106 fires a missile, which can be guided automatically to the target, destroying it utterly. And some of the missiles carry atomic warheads.

The plane I was sitting in was on a ramp at Tyndall Air Force Base in Florida. I had come specifically to participate in the Air Force's new combat-tactics school. Here, in fighter-pilot language, you're taught the real essential—dogfighting, man-against-man, plane-against-plane—and in a way they never taught us.

In my day, they taught us how to fly, gave us the rudiments of navigation and gunnery, then slapped us on the back and sent us into combat. We survived on sheer instinct, plus trial and error. At Tyndall, they don't depend on instinct. The weapons are too powerful, the

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Ball Game

planes are too fast, and the stakes are much too high.

I felt privileged to be there. I was the first writer allowed to participate in the school. In its three years of existence, it has probably become the best in the world. Even the U.S. Navy and friendly foreign nations send their pilots through the courses.

The Interceptor Weapons School, as it's known, does it all. They take on individual pilots and teach them basic aerial-combat tactics, one plane against one plane, and the pilots then go back to their own squadrons as instructors and pass the training on to the rest of the troops. Then, when an entire squadron is ready, IWS takes it on, too, and teaches the pilots in groups how to put these basic tactics to work in a simulated combat situation: escorting a strike force of bombers and defending it against enemy fighters; intercepting such a strike force of bombers and attacking it and its fighter escort; escorting a slow-type patrol (such as reconnaissance planes photographing a certain area) and attacking such a patrol; and, finally, pure fighter combat, one squadron against another.

Our mission for the day. We were to attack an incoming strike force and its escorting fighters. Air Force pilots of the 84th Fighter Interceptor Squadron of Hamilton Air Force Base, Calif., flying F-106s, were pitting their skills against Navy pilots of the VF-92 and 96 Fleet Squadrons of Miramar, Calif., flying F-4 Phantom IIs. The Navy would be the Bad Guys. We, in the 106s, would be the Good Guys.

The day before, to make sure I was "brought up to speed," Ed Woelfel, Operations Officer of the IWS, had briefed me on some of the basic combat tactics. Then he and one of his flight leaders, Captain Terry Luke, took me up and demonstrated, plane against plane, what some of the maneuvers are like in the air.

It had been more than 25 years since I was in combat—but before they were through with me, it felt like 25 light years.

Early in the morning, Ed Woelfel brought a hard-boiled egg to the briefing room and held it in front of my face, fat side down.

"It all starts here," he said. "Every plane has an eggshell, and no two are alike."

He explained what he meant. The operating envelope of an airplane is an imaginary, but very real, three-dimensional piece of the sky that it would use if it performed all its violent maneuvers, horizontally and vertically and anywhere in between, and at minimum and maximum speeds. The final shape described by all of them together would very much resemble an egg.

A horizontal tight turn, for instance, performed at minimum speed above stalling, would fall somewhere near the top of the eggshell.

A horizontal tight turn, at maximum speed, would fall at the fat end of the eggshell. The higher the speed, the wider the turn.

As the turns become vertical, the plane flies up and down its eggshell, pulling tighter turns going up as gravity slows the plane, and going into wider turns going down as gravity speeds up the plane.

Theoretically, a plane could fly completely around the

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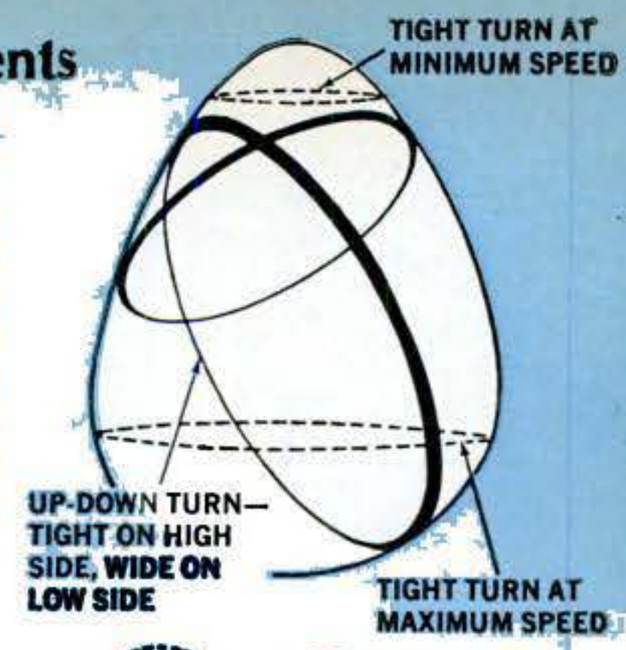
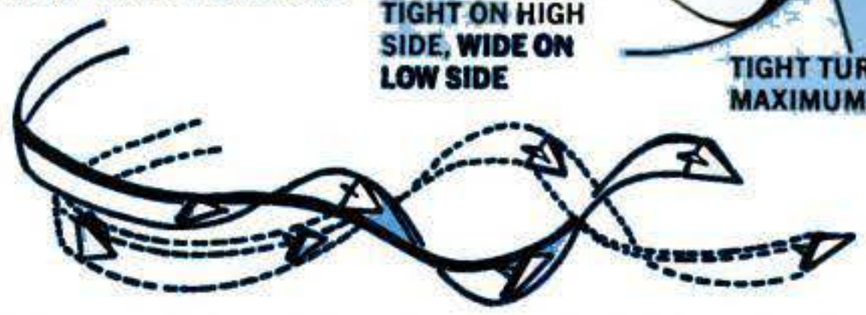
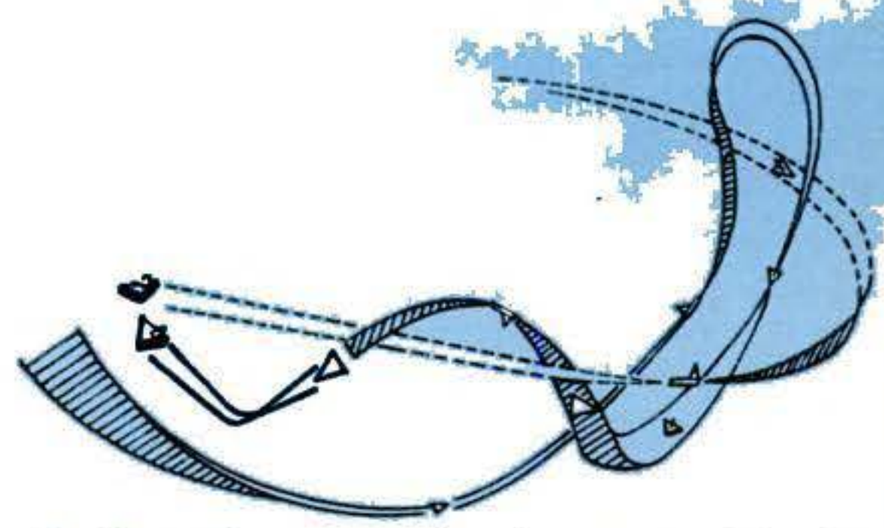
Eggshell represents operating limits

Space eggshell shows a plane's flight envelope. Turns at minimum speed (top of egg) are tight. Turns widen as plane descends, speeding up; tighten as it ascends.

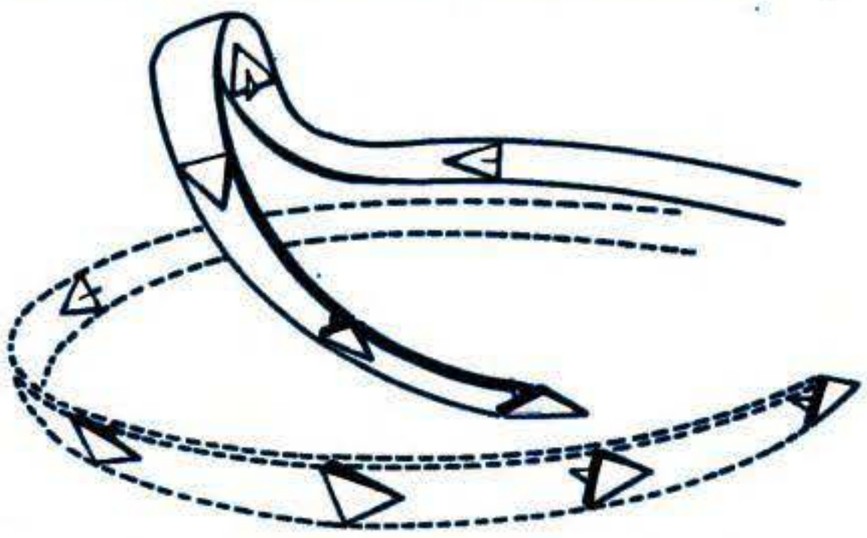




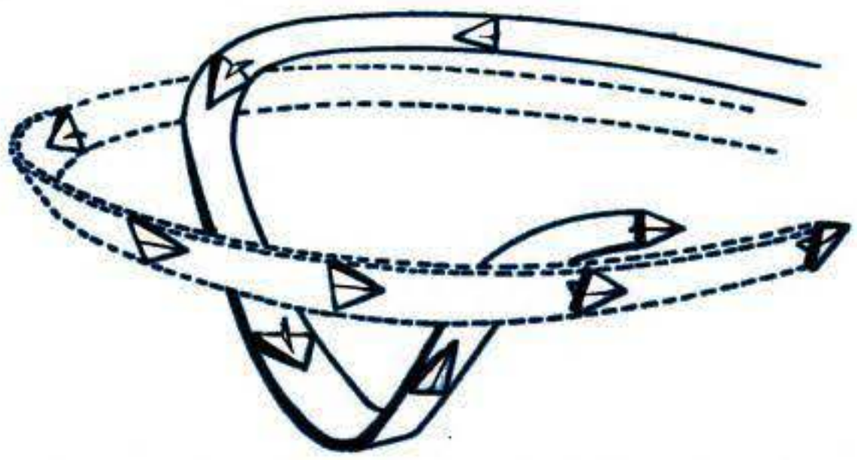
Scissors is defensive maneuver, used when attacker has more speed than defender. Defender (solid band), with tighter turn radius and lower speed, can keep turning back and forth until attacker, going faster and making wider turns, overshoots and presents 12-o'clock target.



Barrel-roll attack puts attacker first under defender's anticipated line of flight to pick up speed; then up, over, and back behind defender. If defender turns in to attacker, attacker zooms up into vertical roll, in opposite direction, toward defender's lethal envelope.



High-speed yo-yo is used when attacker (solid band) has speed advantage and wants to avoid overshoot. He zooms up to reduce speed, turns tight, comes down inside defender's turn. Countermaneuver: As attacker yo-yo's up, defender heads down to gain speed—and separation.



Low-speed yo-yo is used by attacker when there is no speed advantage—a stalemate. Attacker dives under defender's flight path, trading altitude for speed. Zooming up then brings him inside defender's turn. Countermaneuver: turning into attacker as he starts down.

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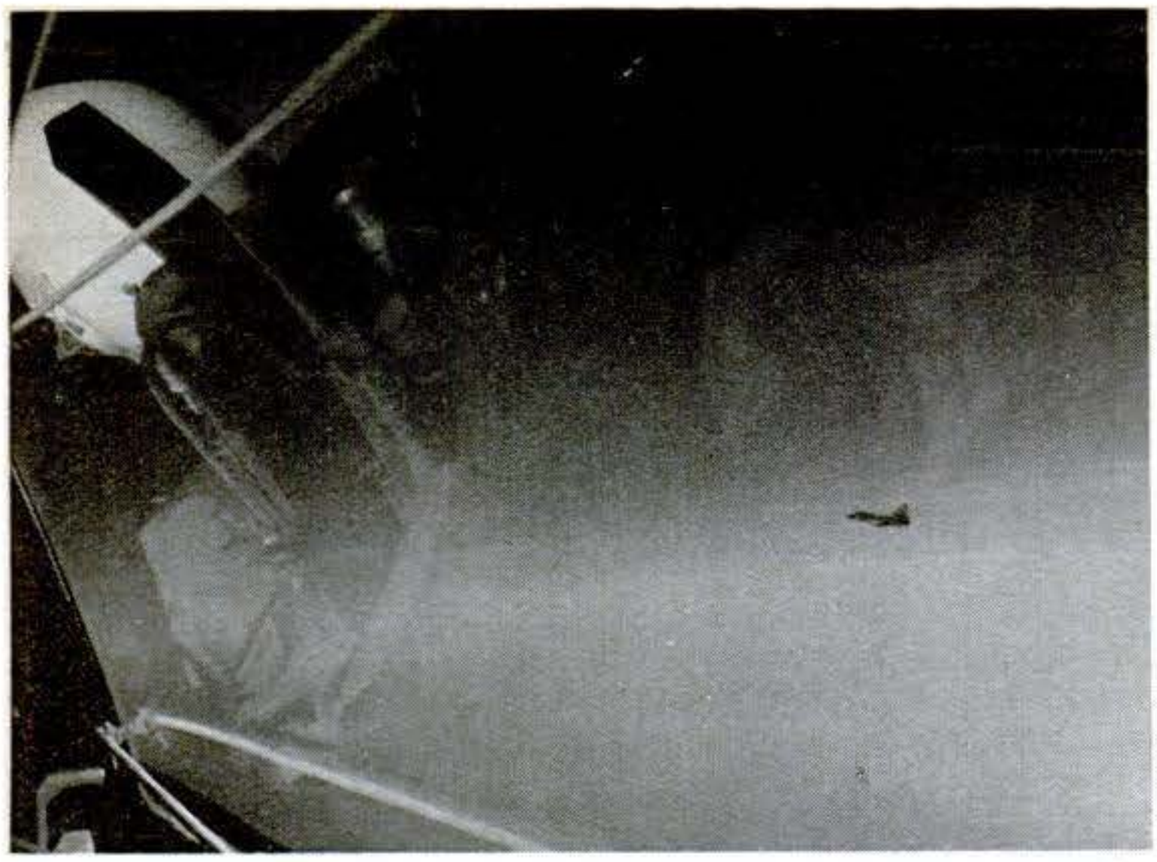

Enemy in sight: Navy F-4 zings by the author's plane during the second run of the mission. This one didn't get away.

edge of its eggshell by performing a loop. The perfect-circle loops performed at air shows are unnatural, done for looks. Fighter pilots want specific effects: tighter turns at more speed. They get tighter turns by reducing power or going up, or both. They get more speed by adding power or going down, or both. So they end up with a not-so-perfect-circle figure—an eggshell.

Ed Woelfel took me around one, explaining along the way, "Here at the top we're at minimum speed with power on because of gravity, but we're making our tightest turn. As we go over the top and start down, the turning radius flattens out even with the same back pressure on the stick, because we're picking up speed all the way. It's flattest of all as we round out the bottom. These things are important to know if you're going up or down after a target."

Once the fighter pilot learns his own plane's eggshell, he then applies it against another plane in simulated aerial combat. And here I picked up another phrase, plus a clue that we, in the old days, had one advantage over today's fighter pilots.

The "lethal envelope." That's the phrase, and it signifies an imaginary cone extending from a fighter plane's tailpipe. If an attacking fighter maneuvers within this cone, his automatic weapons are almost certain to score a kill. Outside this envelope, the kill is more uncertain, if not impossible.

The advantage we had is that, using machine guns, we could send out a steady spray of bullets and attack a target from almost any angle, and let him fly through the spray. The six o'clock position, directly behind a target, was obviously the best place to be, because the fire could be directed with more accuracy. But we weren't confined to it. Today's fighters, however, firing one "bullet" at a time, almost certainly are.

So, as one fighter pilot summed it up, "when you're attacking, you try to run your nose up the other guy's tailpipe and pull the trigger. When you're being attacked, you try to swish your tail around where the other guy can't get at it."

With Terry Luke flying as our pliable patsie, doing all the things we wanted him to do so we could duplicate the textbook tactics, Ed Woelfel showed me some of the maneuvers used to run our nose up the other guy's tailpipe, and other maneuvers to swish ours around where he couldn't get at it. Here are some of them, plus the geometry behind them:

Defensive turn. The oldest, and still the best, maneuver. "Turn into him," we used to say. It points your lethal envelope where the attacker can't get at it.

Scissors. A form of aerial judo, where the defender becomes the attacker. If the attacker has overtaking speed, he's flying closer to the bottom of his eggshell than you are, and will be making wider turns. So start a defensive turn, then reverse it. As he tries to follow each reversal, you'll be using up less air space—flying near the top of *your* eggshell—so you'll eventually end up behind him.

High-speed yo-yo. When you're on the attack with overtaking speed, to prevent an overshoot or a scissors maneuver, fly up toward the top of your eggshell to kill off some of the speed and tighten your turn, then drop down into the target's lethal envelope.

Low-speed yo-yo. When you're on the attack with no speed advantage, and the target turns into you, it's a stalemate. So fly toward the bottom of your eggshell to pick up speed, then use the extra speed to cut off the target, zooming if necessary into a high-speed yo-yo.

Barrel roll. One of the most versatile attack weapons, used to foreshorten closing rate without losing actual airspeed. You fly a corkscrew pattern around your target's straight line-of-flight, using up more air space, but maintaining your speed advantage until in position to move into his lethal envelope.

High-g rolls. Defensive maneuvers, used when your opponent has moved in dangerously close. When going up, you deliberately pull the plane in tight to dissipate speed, causing your attacker to overshoot. When going down, you pick up speed quickly, and you can zoom up and put distance between you and your attacker.

There are others—jinks, diving spirals, vertical rolling scissors, and zoom quarter rolls—and there are countermaneuvers for each of them, and counter-countermaneuvers, too. It takes the average fighter pilot about 45 days to learn them.

Good guys vs. bad guys. As Ed Woelfel climbed into the front cockpit, to start our training mission, he gave me a dubious look. "Ready?"

I showed him both hands, palms up. "Ready as I'll ever be." And we took off to stop the Bad Guys from bombing our friendly territory.

The Air Force F-106s (flown by the Good Guys) and the Navy F-4s (Bad Guys) had similarities and differences. They were about equal in speed, but the F-4, with two engines, accelerated better, while the 106, being lighter, could turn tighter. More significant, the 106, because of its huge delta wing—which is both wing and horizontal stabilizer—could maneuver better in the thin air of high altitude. The F-4, with its more conventional configuration, performed better in the dense air of lower altitudes.

We stationed ourselves at 30,000 feet, but the Strike Force came in at 20,000 feet. We'd have to go down after them into their element, and I'd have to try to remember everything I'd been told. Going down, we'd be flying to the bottom of our eggshell, picking up speed, so we'd probably overshoot, and have to go into a high-speed yo-yo, or a barrel roll. Meanwhile, the F-4s would go into countermaneuvers . . .

It all happened so fast, I never saw a thing.

The ground controller got us into position to make the intercept, Ed moved the throttle to military power, the needle jumped to Mach 1.2, and we and the rest of Red Flight moved forward at supersonic speed. Eventually, Red Leader picked up the Strike Force on his own radar.

Moving my head from side to side in the back seat, I was trying to spot the oncoming enemy, when Red Two cut in: "I've got a Tallyho! Eleven o'clock low."

All hell broke loose. There was a muffled explosion behind me, as Woelfel threw our engine into afterburner—maximum power—and rolled Red Three over on its back.

[Continued on page 144]

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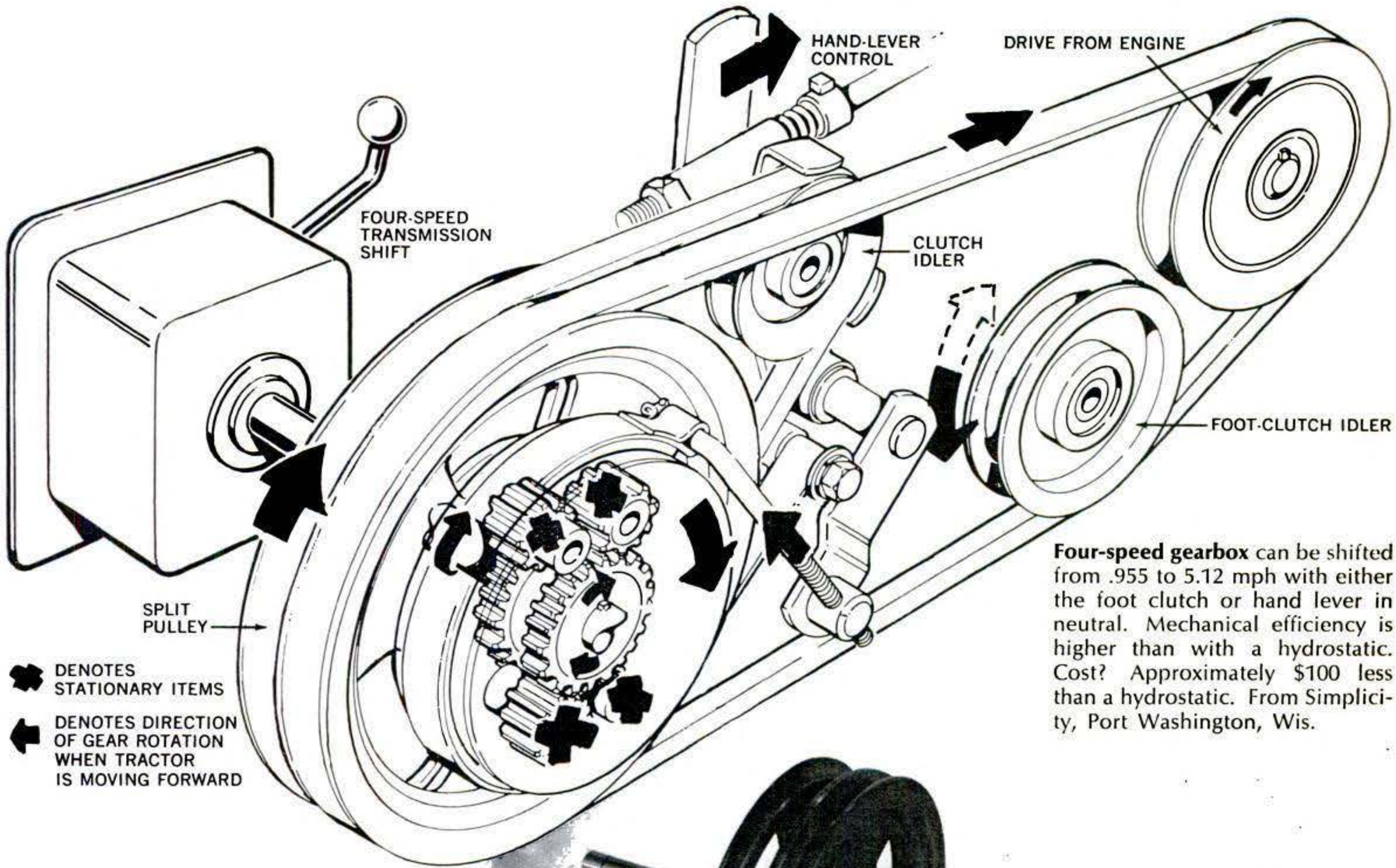
WOW! Instant Forward-Reverse Tractor Drive

By E. F. LINDSLEY



Four-speed gearbox can be shifted from .955 to 5.12 mph with either the foot clutch or hand lever in neutral. Mechanical efficiency is higher than with a hydrostatic. Cost? Approximately $100 less than a hydrostatic. From Simplicity, Port Washington, Wis.

Shifting gears on a small tractor is a breeze with this new transmission

Half the split sheave, left, is keyed to shaft. Driven by engine belt, main sheave is locked to center gear, spins free of shaft. Center gear, held, is keyed to shaft. Drive from main sheave goes through center gear to planets and back to center gear for reverse, when brake band around the planet carrier is tightened by the operator.

Drive Simplicity's new four-speed shuttle transmission on the 10- or 15-hp '72 tractors and you're in for some surprises. If you're an old hydrostatic hand, the action will feel familiar, but you'll have an extra lever to pick any of four speed ranges. Used to straight mechanical drives? The smooth single-lever, shuttle shift from forward to reverse, and the dynamic braking will all delight you with the absence of gear blockout and clash.

The secrets behind Simplicity's shuttle transmission:

- A split-V pulley that acts as a clutch when the belt is snugged.
- Planet gears in constant mesh for forward and reverse.
- A brake band to lock or unlock the planet carrier.
- A damping spot brake for no-creep neutral.
- A four-speed gearbox.

To understand the unique drive, think first of a direct V belt from engine to transmission input pulley with a foot-operated, belt-tightened clutch. With this you could select a suitable speed and start and stop the tractor but you'd have no reverse. Now, let the input pulley spin freely on the transmission shaft and provide a clutch so the pulley can engage the shaft at will. The second, split-groove in the input pulley does this. Tighten the belt, which has a free-spinning idler at the other end, and the two sides of the V turn together to drive the shaft. Loosen the belt and the input pulley spins on the four-speed transmission input shaft in neutral.

Now locate a set of planet gears in a carrier in the hub of the input pulley. Key the center gear to the shaft. When the split-V clutch is locked up, the entire mass—input pulley and planetary—spins as one. When the clutch belt is loosened, the input pulley and planet gears rotate about the central gear and shaft in neutral. Tighten the brake band on the planet carrier and the planet gears act to turn the center gear and shaft in reverse.

Thus, in a shift either direction, no gears are meshed or demeshed. PS

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Liquid Crystals: Those New

Now you see them, now you don't. Liquid crystals do their thing in digital displays

By RONALD M. BENREY

The gadget looked like a square of ordinary plate glass. I held it up to the light and cocked it slightly.

"I can see a pattern of hazy blue bars," I said.

"You're looking at the transparent electrodes," said Andy Bosso, an executive at RCA's Solid-State Electronics Division, in Somerville, N.J. "Now let me show you how the display works."

Bosso plugged the little glass module into a socket atop a small black box full of integrated circuits and batteries. "This is our demonstration power supply," he said. Then he flipped a switch.

Instantly, a milky-white numeral *1* appeared within the glass square. After a few moments, the number changed to *2*—then *3*—and onward through the 10 digits.

We watched the digit cycle repeat several times, then Bosso turned off the power supply. The digit on display dissolved like a wisp of smoke, and the glass turned clear again.

"What do you think of our liquid-crystal display?" asked Bosso.

"Fantastic!" I said. And fantastic is really the right word to describe the blossoming new technology of liquid-crystal electronics. This amazing way of displaying numbers—and possibly pictures—has hit the electronics industry like a bombshell.

- Right now you can buy a $100 electronic calculator built by Ragen Precision Industries, North Arlington, N.J. [PS, Jan. '72] that uses an eight-digit LC display to flash answers to the operator. Industry experts I spoke to agreed that most upcoming low-cost calculators will have liquid-crystal displays.
- Similarly, virtually all the digital electronic wristwatches now under development are being designed around LC displays. For reasons we'll talk about shortly, liquid crystals create the only practical read-out system for watches.
- Liquid-crystal displays for use in aircraft cockpits are being designed now. The next step is LC speedometer and engine-instrument displays for car dashboards. These will be ready by the late Seventies, when car makers begin replacing mechanical instruments with microelectronic equivalents [PS, Oct. '71].
- Scientists are talking cautiously—but optimistically—about using arrays of LC display elements to create a large flat-screen TV "picture tube." There are thorny problems to be solved, but, in concept, liquid crystals seem better suited to the job than other electro-optical devices, including light-emitting diodes (LEDs).

Cadging free light. The prime advantage of an LC display in most applications lies in the simple fact that the display is not itself a *source* of light. LEDs, pilot lights, and other electrically powered display devices actually *emit* light. But, an LC display module uses existing ambient room light to illuminate the digit.

This difference may sound minor, but it's actually enormously significant. The reason is that generating light takes lots of electric power, while ambient light is free.

A typical LC display uses only about 1/10,000 of the electric power drawn by an equal-sized LED digit display. Clearly, LCs make battery-powered displays a practical reality for many purposes.

The classic example is the battery-powered electronic watch that displays the time digitally (in actual numbers). LCs use such little current that a tiny battery will be able to power a digital watch for about one year, with the display always turned on for time-telling.

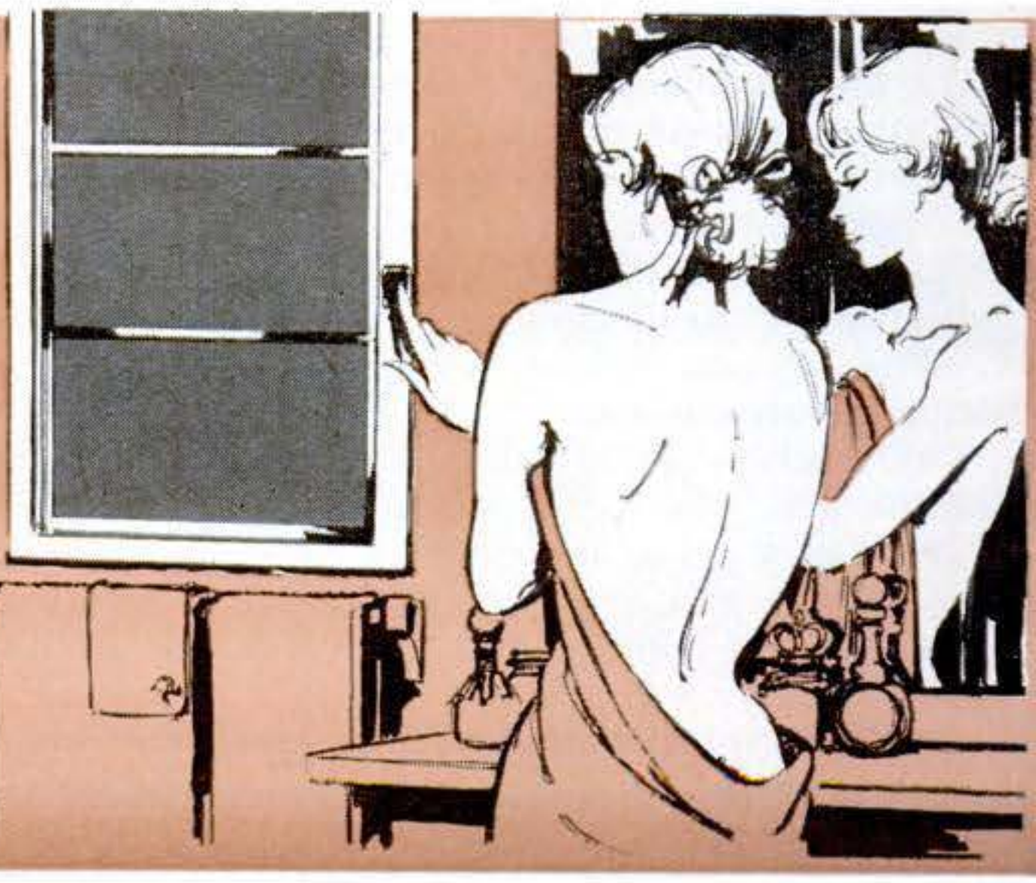
Watches using LED displays—like the Hamilton Pulsar—have been built, but these all have pushbuttons and you turn on the display only when you want to know the time.

The LC display digits materialize like visions in a crystal ball because of the unusual properties of the strange material sandwiched inside the module. Liquid-crystal substances look like colorless, transparent liquids, yet they can manipulate light waves like solid crystalline materials.

The molecules in an LC material are very large—often made up of several hundred individual atoms—and are shaped like long elliptical rods, much like elongated grains of rice. Many LC compounds are being studied, all with jaw-breaking names like *p-methoxybenzylidene-p-n-butylanaline* or *1,4phenylene bis-4-n- alkoxy benzoate.*

Dozens of major electronics and research companies—including RCA,

Sun-visor section of liquid crystals laminated into top of a windshield could cloud up at the touch of a button to shade your eyes while driving. Cost is the biggest stumbling block.



Electronic window shade—press a button and the window clouds up—would be right at home in your bathroom. Liquid-crystal technology can do a lot more than just show numbers.

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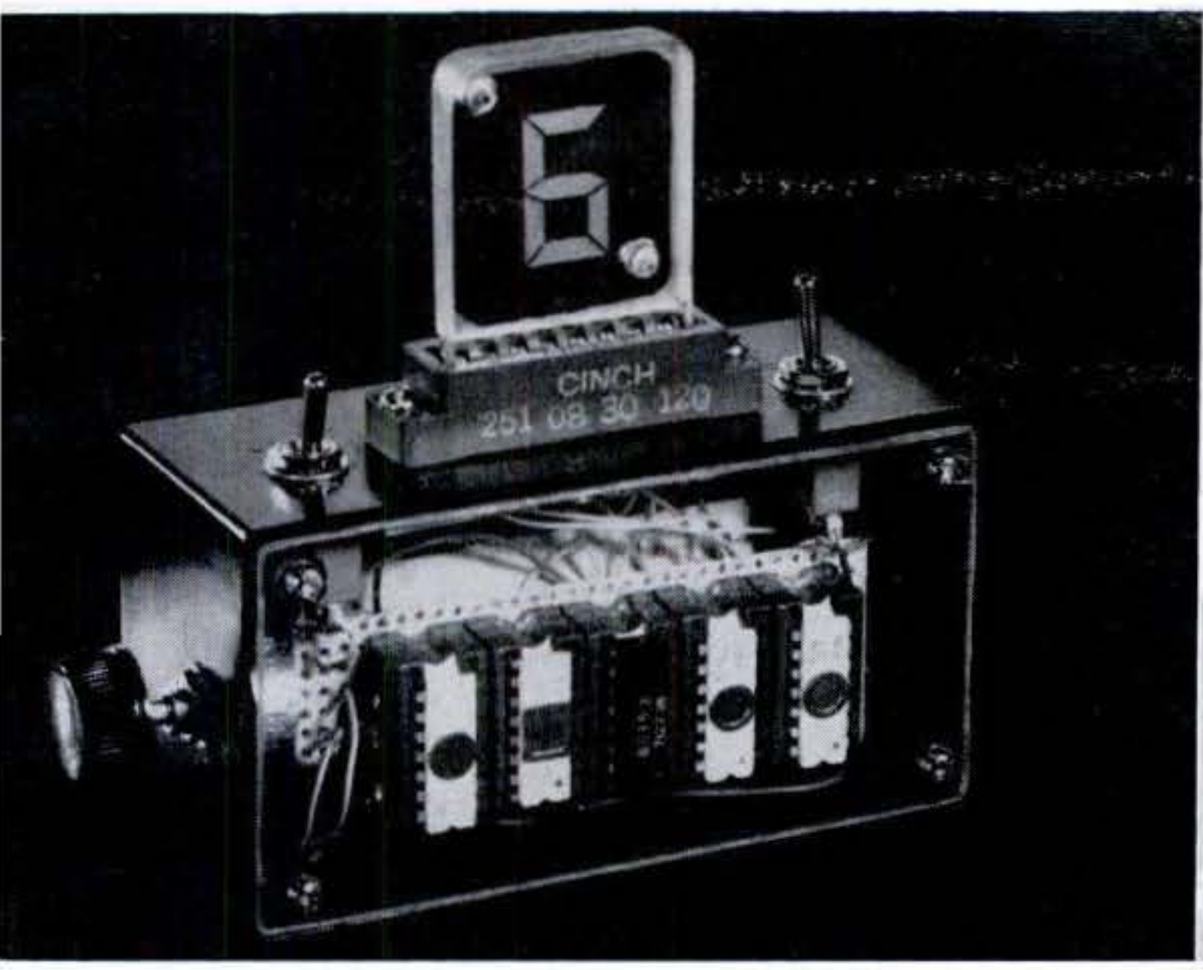
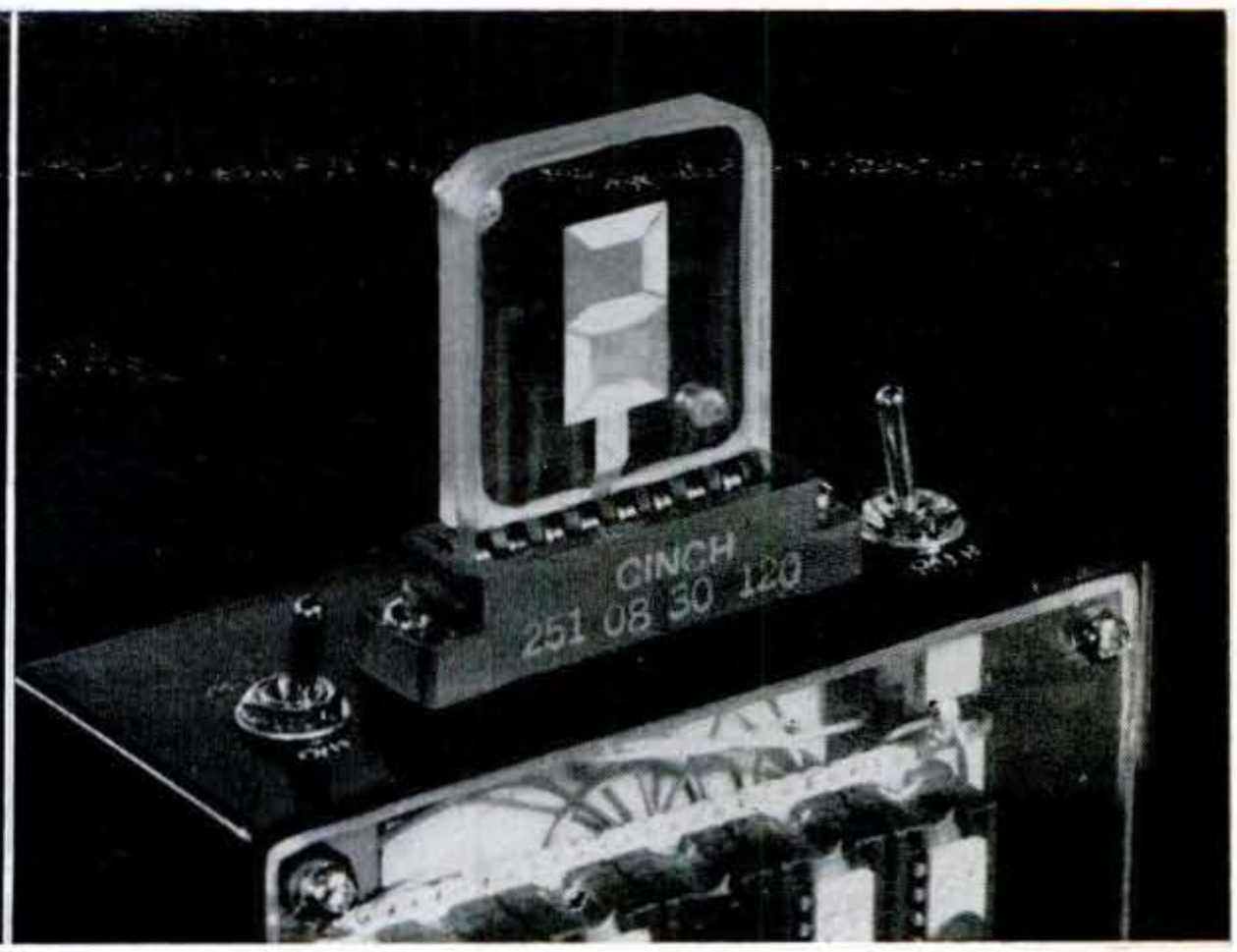
Electronic Showoffs



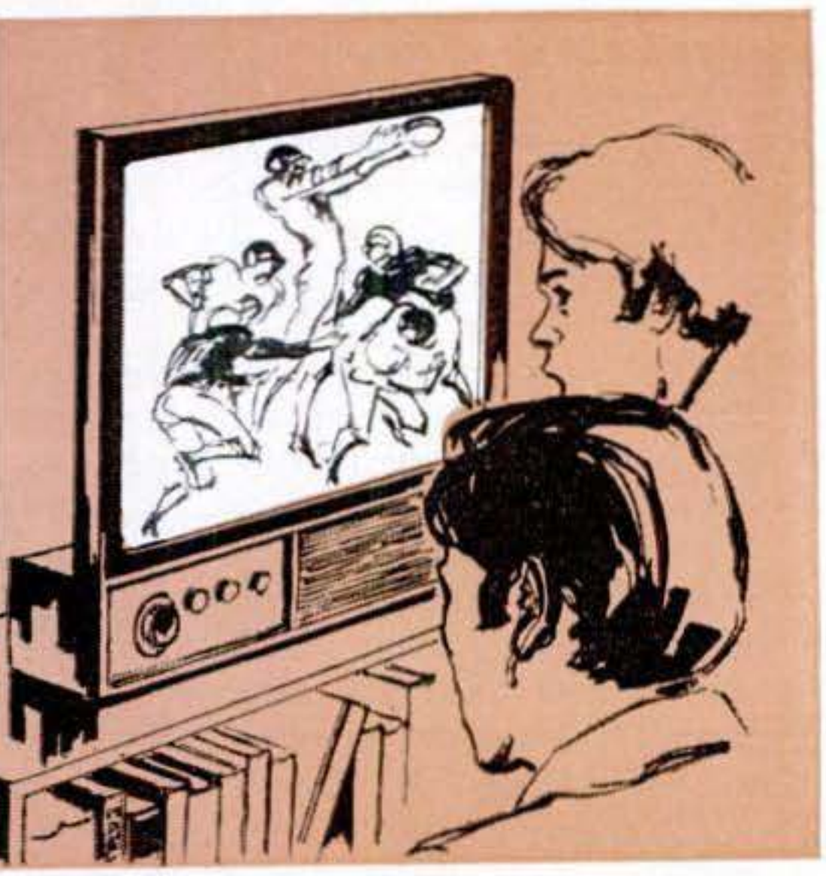


Liquid-crystal display device by RCA shows the two types of LC displays. Above at left, a transmissive device, best seen by illumination from the rear. Above at right, a reflective display, with the digit superimposed on a metallic background.

GE, Motorola, Texas Instruments, and IBM—are working on LC displays, and each company has its own witches' brew of secret ingredients.

Betwixt and between. At low temperatures, LC substances are solids; at high temperatures they act like ordinary liquids. But, in between, they assume an inbetween nature that scientists call a *mesophase*—the liquid crystal state. Even though the substance flows like a liquid, its molecules are arranged in a neat, orderly pattern, much like a solid crystal.

Different molecular patterns are possible, but most display LCs fall into the nematic (thread-like) category. Simply put, the long molecules lie parallel to each other, like strands of spaghetti in a box.



Flat-screen TV tube using LCs may be possible if scientists can develop liquids with short decay times, long life spans.

Chemists have known about LC substances for over 80 years, but it wasn't until 1968 that RCA scientists discovered that a thin film of nematic LC is capable of electro-optical magic. When a film about 1/1,000-inch thick is pressed between two electrodes that apply a voltage across the film, the LC suddenly turns milky white. When the voltage is turned off, the LC rapidly clears and becomes transparent again.

Because the LC "liquid" is not a good conductor of electricity, a negligible current flows through the film when the voltage is present—yet, the presence of the voltage temporarily transforms the LC from a clear material into a translucent substance that looks like a wafer of frosted glass.

Chemists aren't completely sure of what is happening, but the best explanation I have heard is a simple one: The electric field between the activated electrodes sets into motion the small number of impurity molecules within the film. These jostle the large LC molecules, and ruin the neat nematic pattern. The long elliptical molecules are shoved into a jumble that scatters light waves striking the film. As a result, the film appears cloudy.

When the electric field subsides, the impurity molecules settle down, and the LC molecules realign into parallel order. Once again, the film is transparent. The process is called *dynamic scattering* to indicate that the film's optical properties at any

[Continued on page 146]

Shirt-pocket calculator by Ragen makes first commercial use of liquid crystals, marks definite trend in calculator design.

Eight-character liquid-crystal display developed by GE scientists should speed application of LCs in many areas. Display requires only 16 leads compared to 65 for similar devices and cuts costs greatly.

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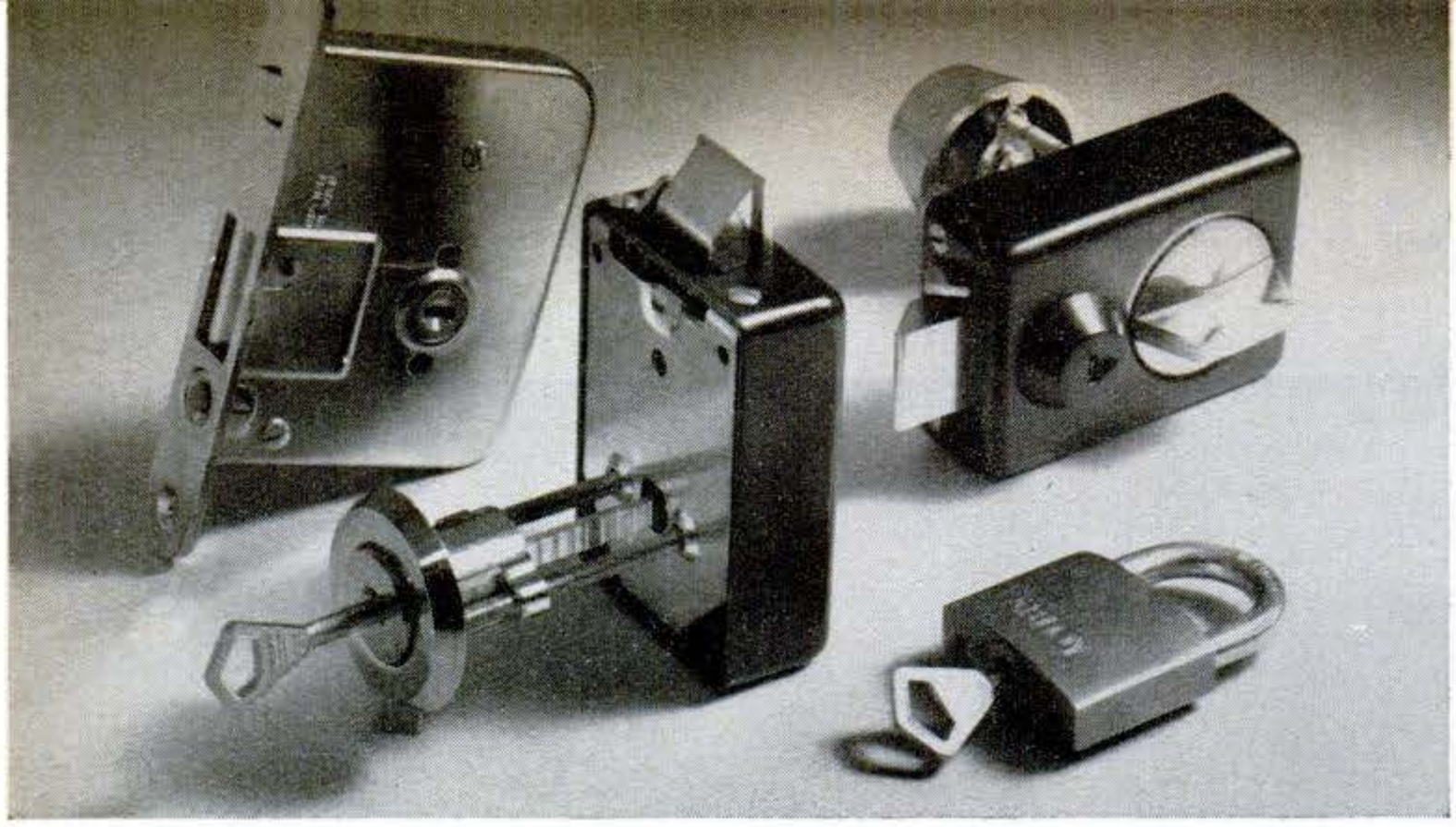


The Lock with No Pins to Pick

Out of Finland comes a lock with a new locking principle. Instead of spring-loaded pins, there are rotating tumbler disks, making the lock virtually pickproof from the outside.

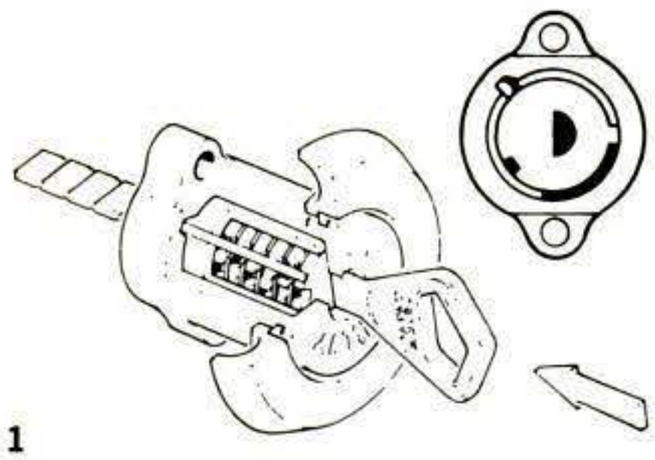
And that's the most important place. A lock's most vulnerable point is the hole where you insert the key. Many are easy pickin's for even the semipro thief.

The problem lies in the spring-loaded pins of the tumbler, which are exposed from the outside. The right jiggle, and a fast turn by an experienced hand opens the lock as fast as you would with a key.

The Abloy lock works something like a slot machine—only your chances of success are worse. A standard Abloy contains eight tumbler disks. Each is notched at one of six possible areas along its circumference. Only the correct key will turn each disk so it lines up directly under the locking bar.

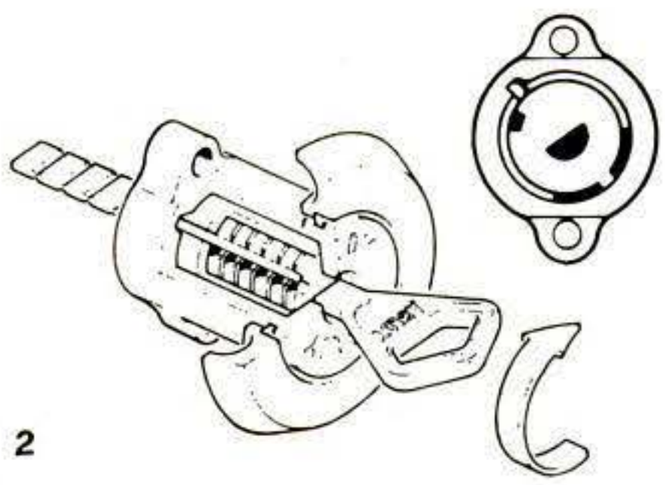
The number of combinations possible is staggering: over 1½ million for the standard eight-disk model—and you can add up to 13 disks on special order. Also, additional notches can be cut in each disk to create a master and submaster key system for security areas or, in some instances, for your home.

Prices vary from $4.40 to $40 for padlocks, and $17.40 to $40 for door locks. General and special-purpose locks are available through local distributors or directly from Inter-Trade Industries Ltd., Box 102, Rouses Point, N.Y.—*W. J. Hawkins*



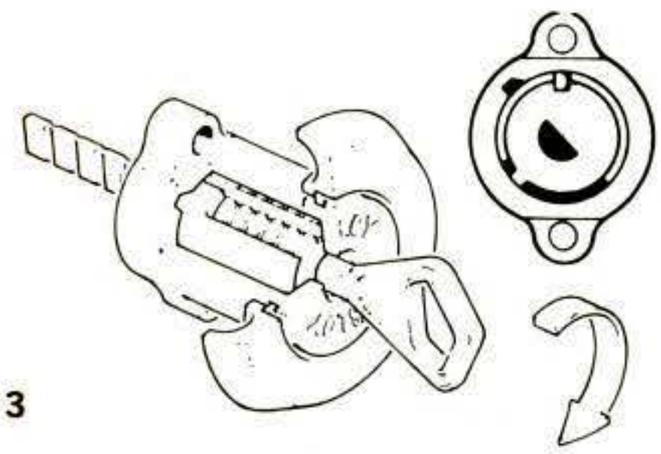
1

The key enters the lock with no resistance or wear. Notches in tumbler disks are out of line, keeping locking bar out of position.



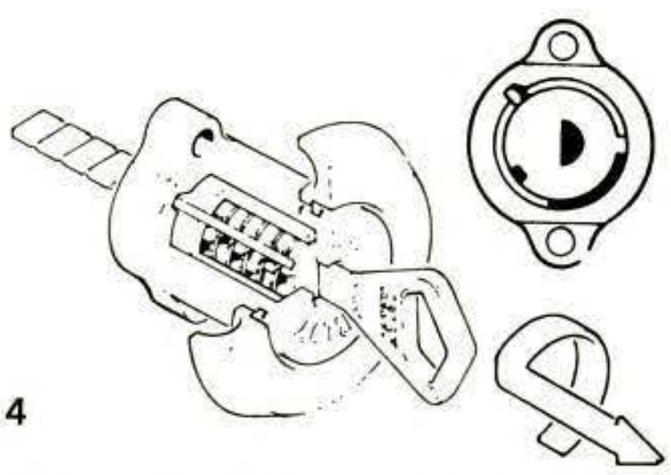
2

Turning the key clockwise lines up the grooves in each disk. A wrong key turns one or more disks too far or too little.



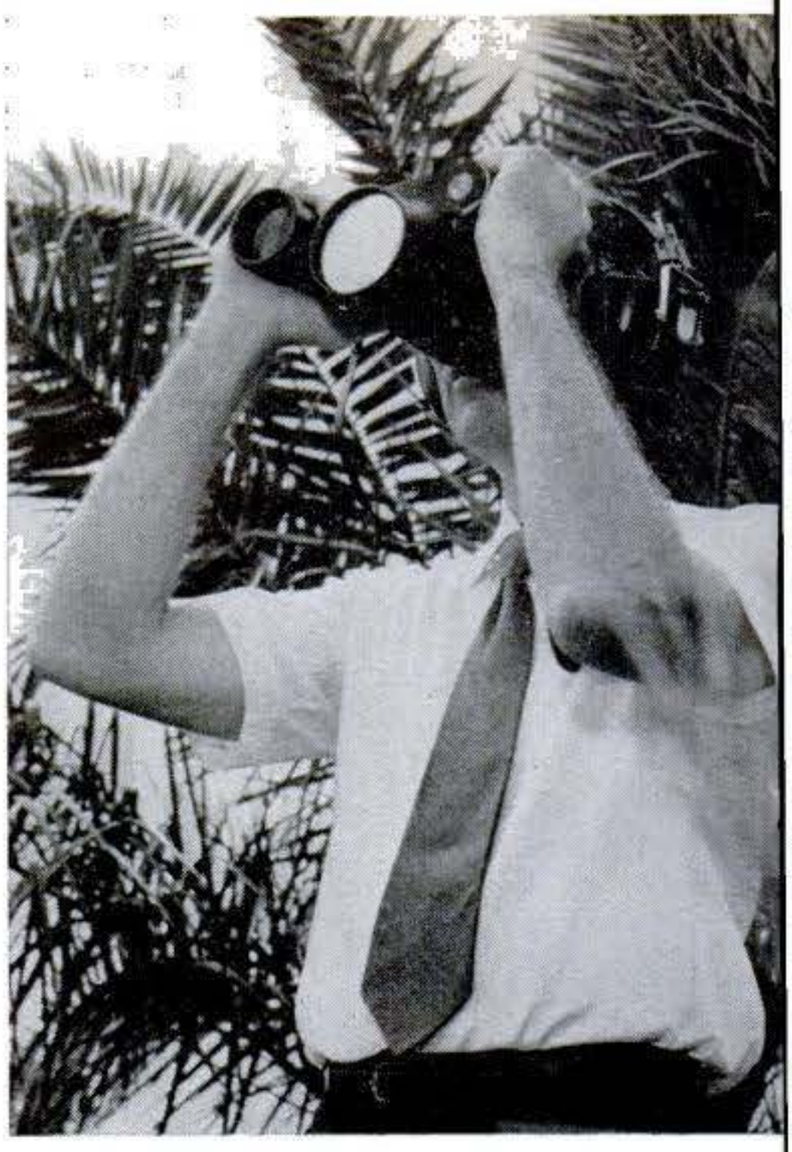
3

As the key is turned farther, the locking bar is pressed against the angular surface of the cylinder. The bar then drops into the groove and the cylinder is free to turn. Continual turning of the key turns the cylinder and operates the bolt. The lock opens.



4

To remove the key, it must be brought back to its initial position by counterclockwise rotation. The locking bar returns into the cylinder and the tumbler disks are placed back in their scrambled position. Remove the key and the lock is secured.



These Binoculars Let You Talk Farther

Little by little, some of the amazing developments in laser technology are coming to light.

Hughes Aircraft Company, which is primarily involved with supersecret gee-whiz projects for the military, recently revealed commercially practical wonder binoculars that enable users to talk to each other over ranges of 10 miles or more.

The unique three-pound unit is a self-contained transceiver coupled with a solid-state electro-optical system. The design is wide-angle enough to permit communication under any situation that allows use of binoculars. And there's a big plus:

The gallium arsenide laser output is infrared. Therefore it is outside the light spectrum visible to the unaided eye. This means that it provides your very own secret "Hot Line."

How far the system works is limited only by weather conditions and the degree of laser-beam divergence designed into the system.

According to Hughes, a three-degree divergence configuration will permit clear communications over four miles when visibility is 10 or more. A five-degree model will transmit clearly for 2.5 miles.

If the equipment is used for ship-to-ship communications when both vessels are in a rolling, pitching sea, the five-degree model at 2.5 miles will provide a beam broad enough to

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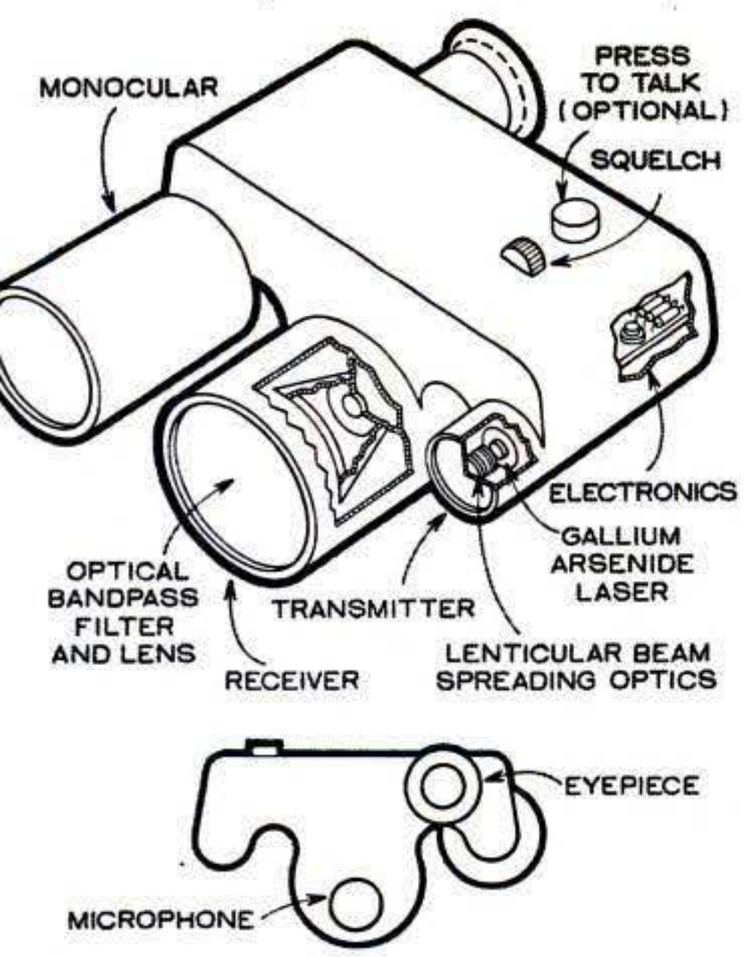


blanket both ships and provide secret uninterrupted two-way contact.

The voice transmission works by circuitry that converts the audio signal into a series of coherent-light output pulses by pulsing the gallium arsenide laser. The light-pulse transmission is actuated by talking into a mike built into the communicator.

The receiving operator optically aligns the instrument to receive the transmitted pulses by simply looking through his binocular and detecting the infrared light. The light is collected by a 2.5-inch-diameter receiver aperture.

The infrared energy coming in is then processed, using special techniques to enhance the signal-to-noise ratio. This is the secret of the small, lightweight design, because it permits use of the small receiver aperture. The received light pulses are then amplified and the repetition rate is demodulated to convert the received pulses into audio or data signals.

This new handheld version is derived from a small lightweight tripod-mounted laser communicator. The handheld version is mobile and useful for ship-deck security, riot control, forestry service communications, helicopter-to-ground contact, and for military defense as a low-cost, secure walkie-talkie unit.

The tripod version has a long-range system with a ¼-degree transmitted laser beam, variable-transmitter-power designs, and data communication. There is also a short-range model with a two-degree beam divergence for landbased operations and a three-degree unit intended for ship to ship. There's even a helmet version that leaves the operator's hand free. The two helmeted men need only face each other to make contact.—*Ben Kocivar*

A White Latex Paint for a Dollar a Gallon?

A high-quality latex paint from resin, water, and lime? That's what Bond Chemical claims for their Weatherbond Resin mixture. I tried it to see how it works.

I mixed 20 pounds of lime with two gallons of water—that's common whitewash. Then I added 2½ gallons of the resin. The resin's thick—like marshmallow—so I needed plenty of mixing sticks and a lot of elbow grease to thin it out. Result? Five gallons of white nontoxic paint.

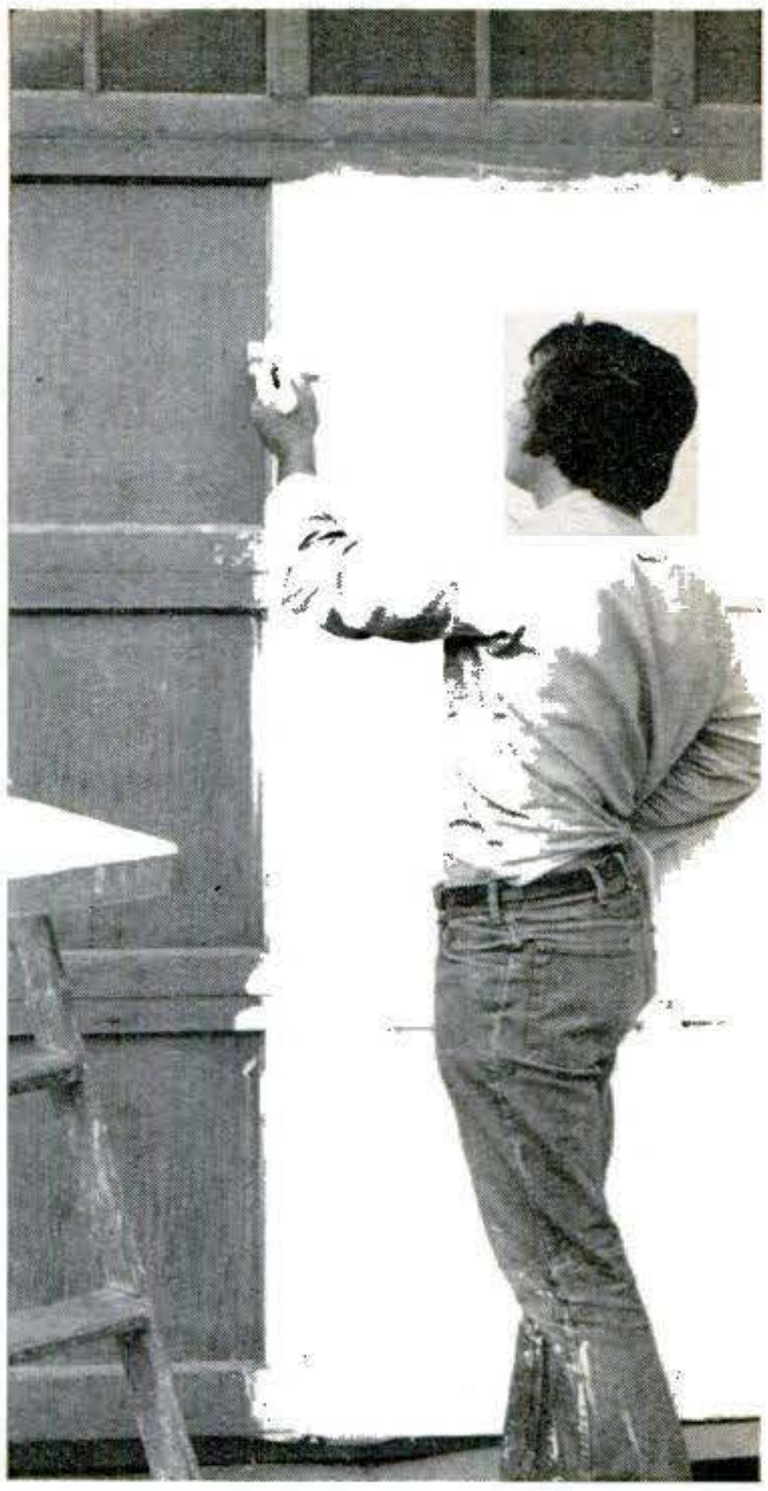
Initial cost of the resin is $2.59 a gallon. The paint mixture? Only $1.33 a gallon. It's even cheaper—as little as 35 cents a gallon—if you use more water and less resin.

Streakproof finish. I put two coats on a green garage door with brush and roller. The paint set fast—15-20 minutes—and the finish was textured like fine sandpaper, not glossy. Rainwater won't streak and dirty the finish (as with gloss).

I tried the stuff on concrete, too. It's even better for masonry—cinder block readily absorbed the paint without leaving gaps.

Time will tell how durable the paint is, but after two months it hasn't cracked, flaked, or washed off. If the stuff holds up, you can save $4 to $5 a gallon on a big paint job.

You can't store the resin under 40 degrees F. It'll gel, and the only way to reactivate it is to add boiling water. It's made by Bond Chemical Mfg., Inc., 118 N.W. Fifth St., Fort Lauderdale, Fla. 33301.—*Doug Garr*



First coat covered this garage door, but author added another. Finish didn't wash off, crack, or peel after a 15-minute high-pressure water test with a garden hose

Mixing the paint was the toughest part of job. Resin needed lots of thinning but yielded twice as much paint after mixing.

One coat of new latex paint applied with a roller easily covered this concrete building.

Copyrighted material

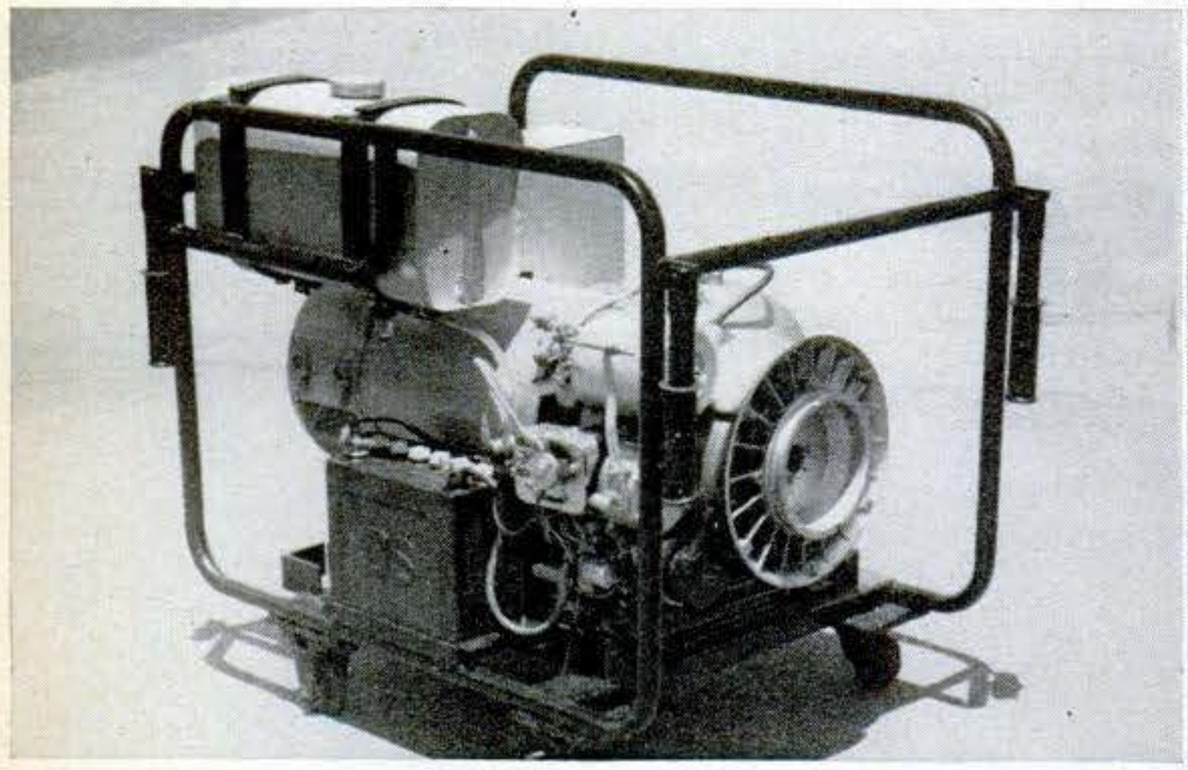
A Wankel-powered garden tractor? Sure. This rugged little unit is powered by a 330cc rotary engine. Advantages over an ordinary garden tractor? Less noise and vibration, less torque fluctuation, no speed-restricting valves, more efficient operation.

The Wankel: All-Purpose Power

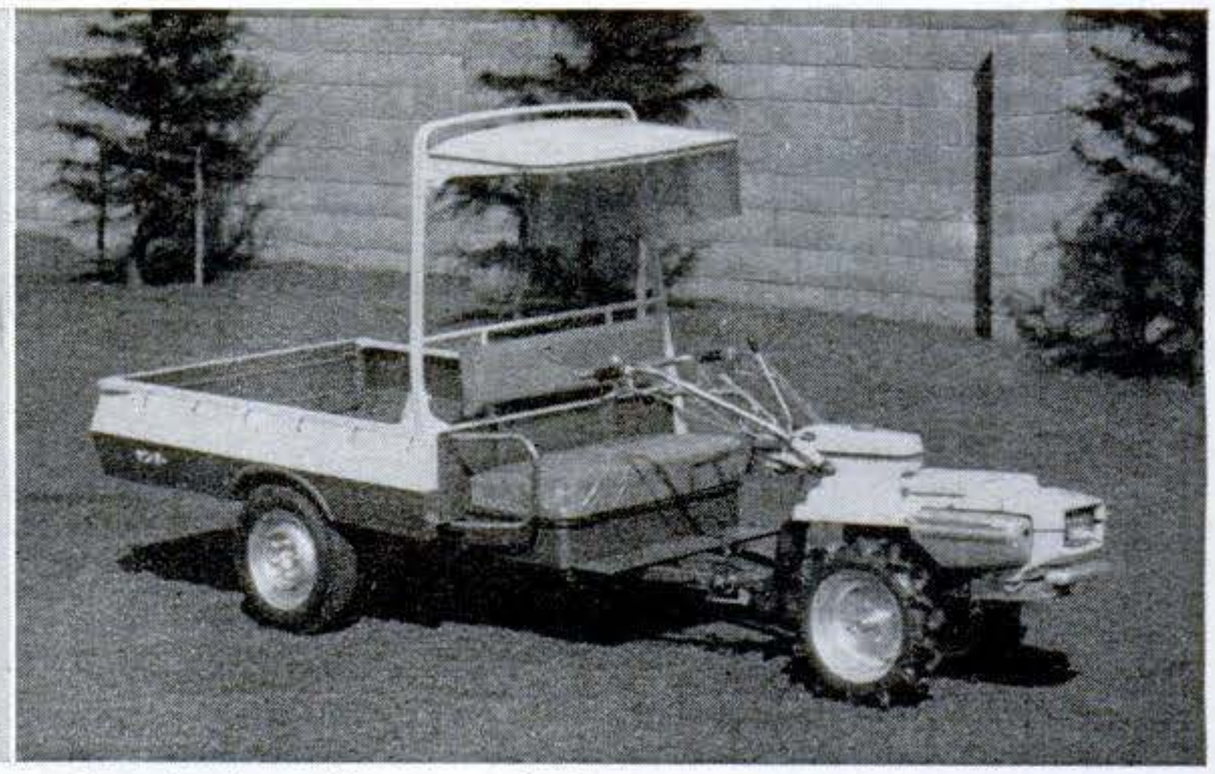
Soon the rotary engine may be powering industrial and gardening equipment

By RAY HILL

Since 1961, Yanmar Diesel in Osaka, Japan, has been researching and developing the rotary engine with an eye toward marine, agricultural, and industrial applications. With the exception of the outboard shown here, all the engines and vehicles shown are prototypes. The outboard is already in production in two models—20- and 45-hp. Nearly 1,500 outboards have already been sold. The other engines and vehicles should be available in the U.S. within the next couple of years. Watch future issues as POPULAR SCIENCE keeps you abreast of the development of these machines. PS



For industrial use, this 330cc air-cooled unit is being developed to power stationary machinery. Gas consumption is less than that in an equivalent piston-powered engine. Starting is easy.



The classiest tiller around—that's what you would have if you could buy this prototype tiller and trailer with a sunroof. The tiller is powered by a 120cc air-cooled rotary engine.

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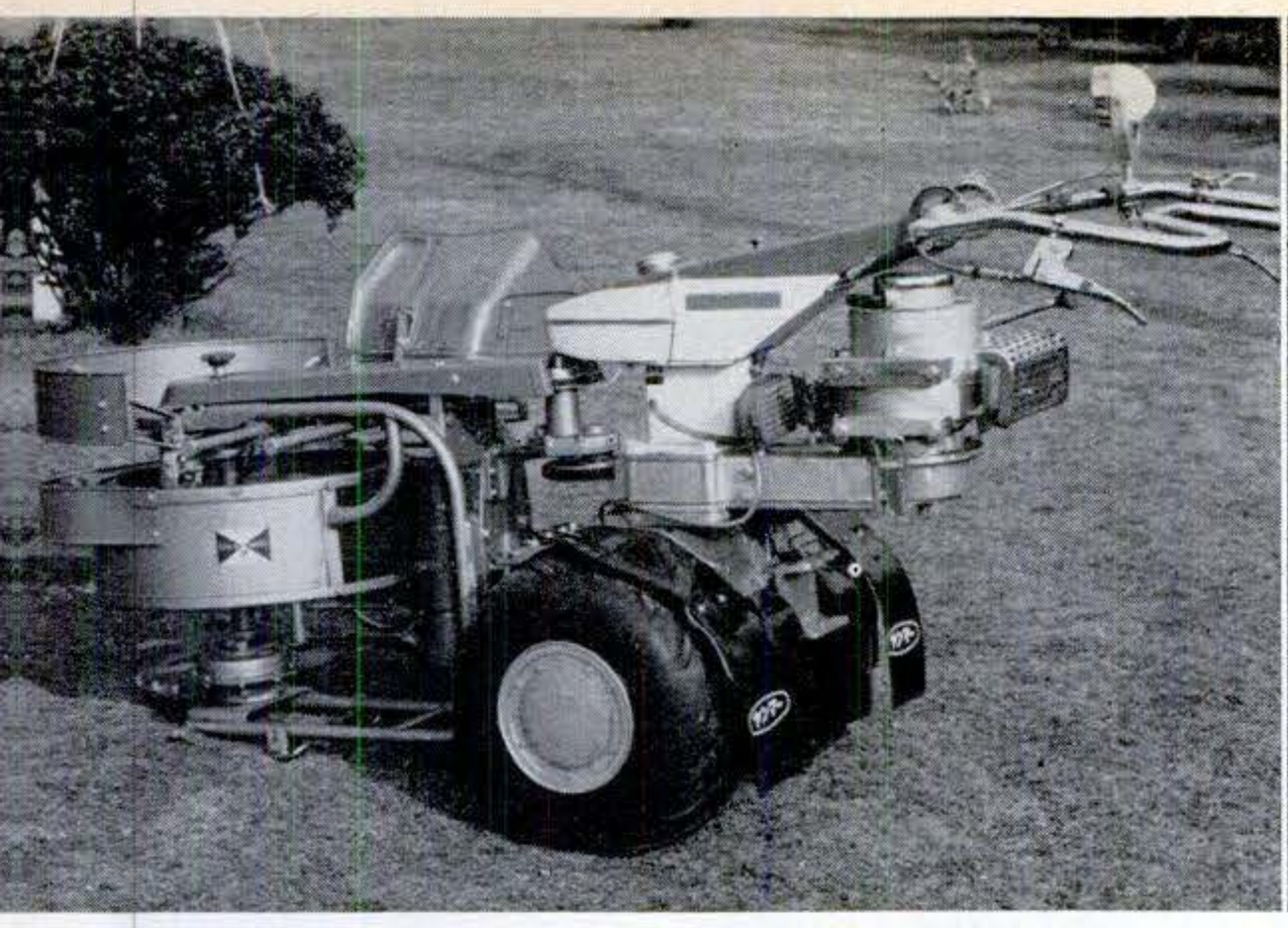
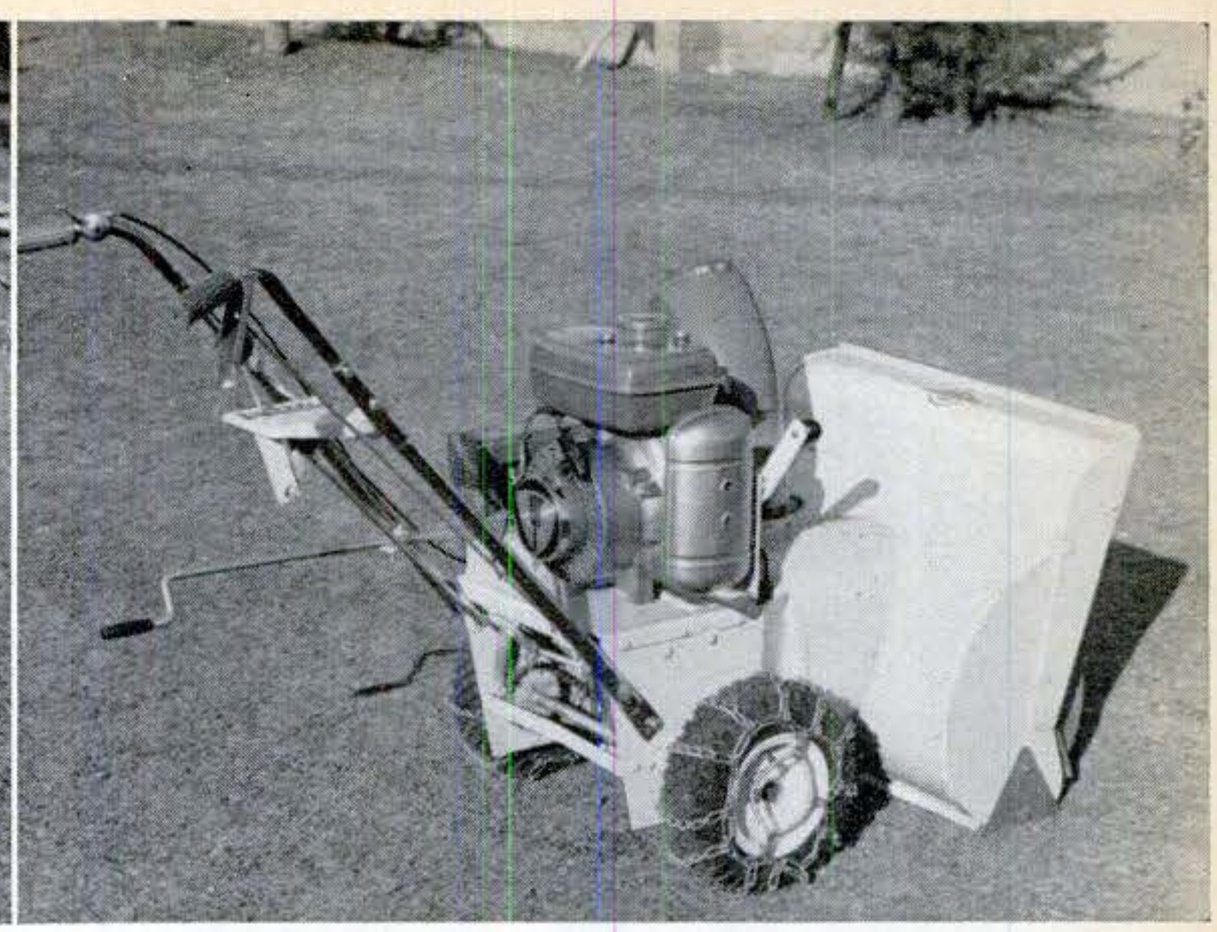
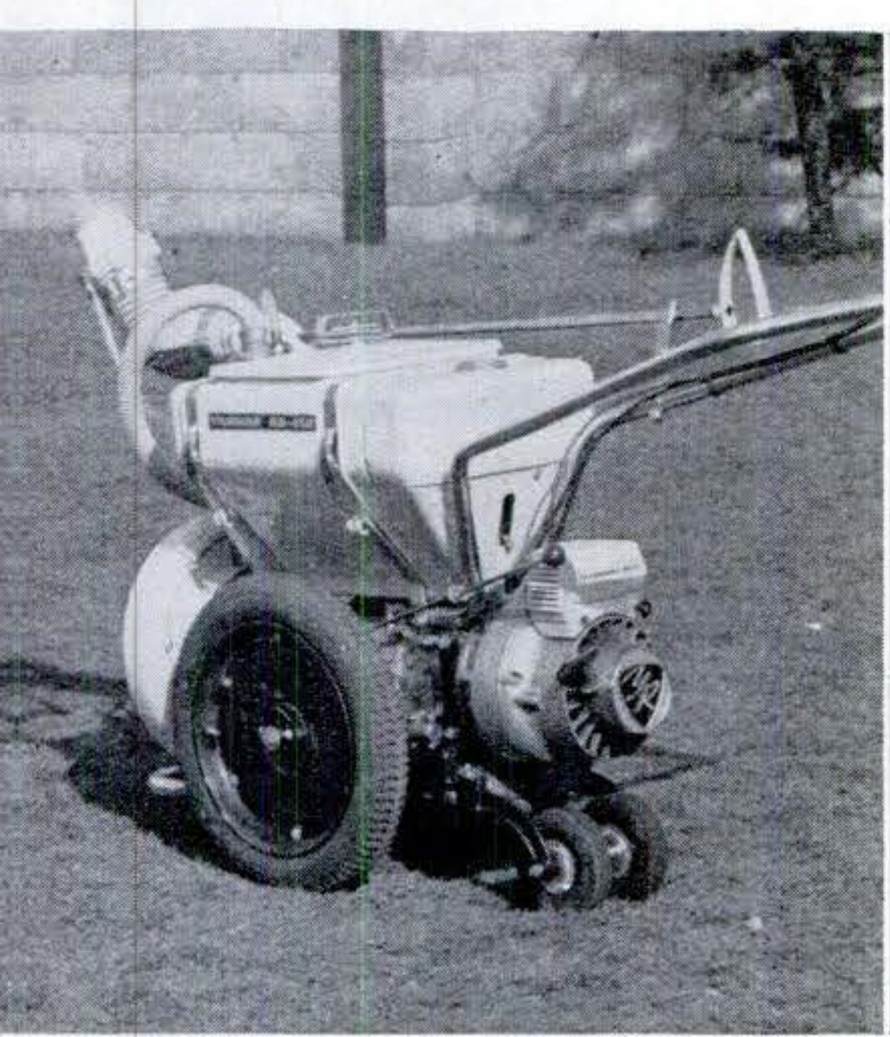
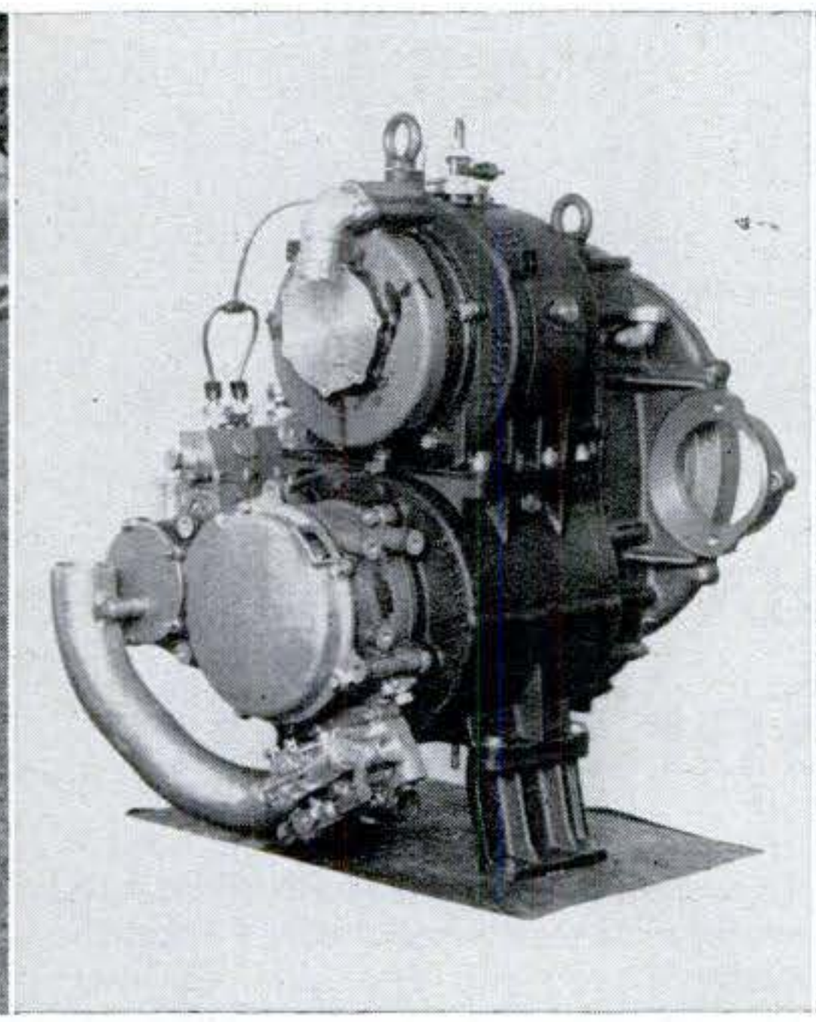


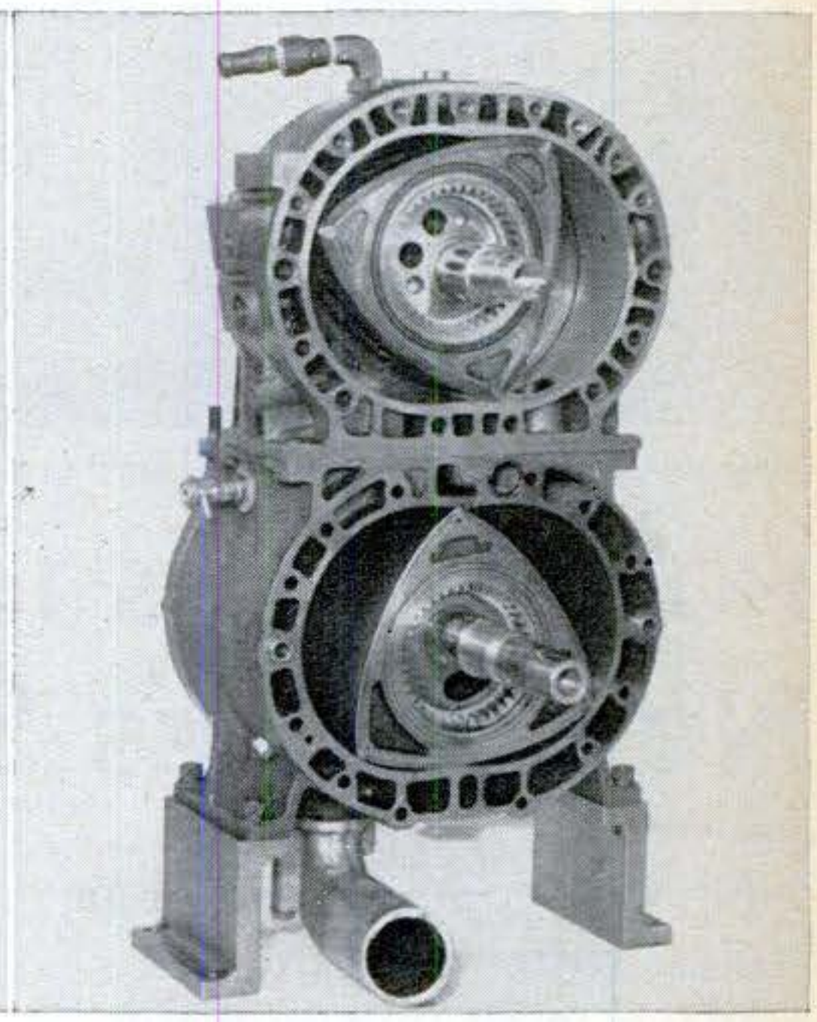


This harvester is powered by a 120cc air-cooled engine—basically the same one used in the tiller. Yanmar is licensed by Audi NSU and Wankel to manufacture and sell the NSU/Wankel system rotary engine—the type of engine shown on these two pages.

When snow is lying deep on your sidewalk, and the temperature is low, you'll probably be thinking of better ways to exercise than by shoveling it away. You'll want a snowblower. Thinking of you, Yanmar's working on a blower powered by a 120cc Wankel.







If you've got more insects than you've got plants, dusting can be a chore. Soon you'll probably be able to do it with this Wankel-powered duster. It sports the same basic 120cc engine used in harvester and tiller.

A rotary diesel? Right. Yanmar is currently developing the model above for industrial use. How does it work? Fuel enters the upper cylinder where it's compressed and forced into the bottom cylinder. The lower cylinder is the combustion and expansion unit. The rotary diesel has a markedly higher power-weight ratio than ordinary diesels and vibrates much less than reciprocating diesels. Maximum output: 40 hp at 3,600.

Above, the R450 takes off in a race. This model and the R220 outboard are the only two Wankel engines now in production by Yanmar. The 45-hp R450 costs $1,600. The 20-hp R220 sells for $800. The rotor housing of both engines is water-cooled. The rotor is oil-cooled. The oil cooler is in the transom unit. Both engines reach their peak horsepower ratings at 6,000 rpm .

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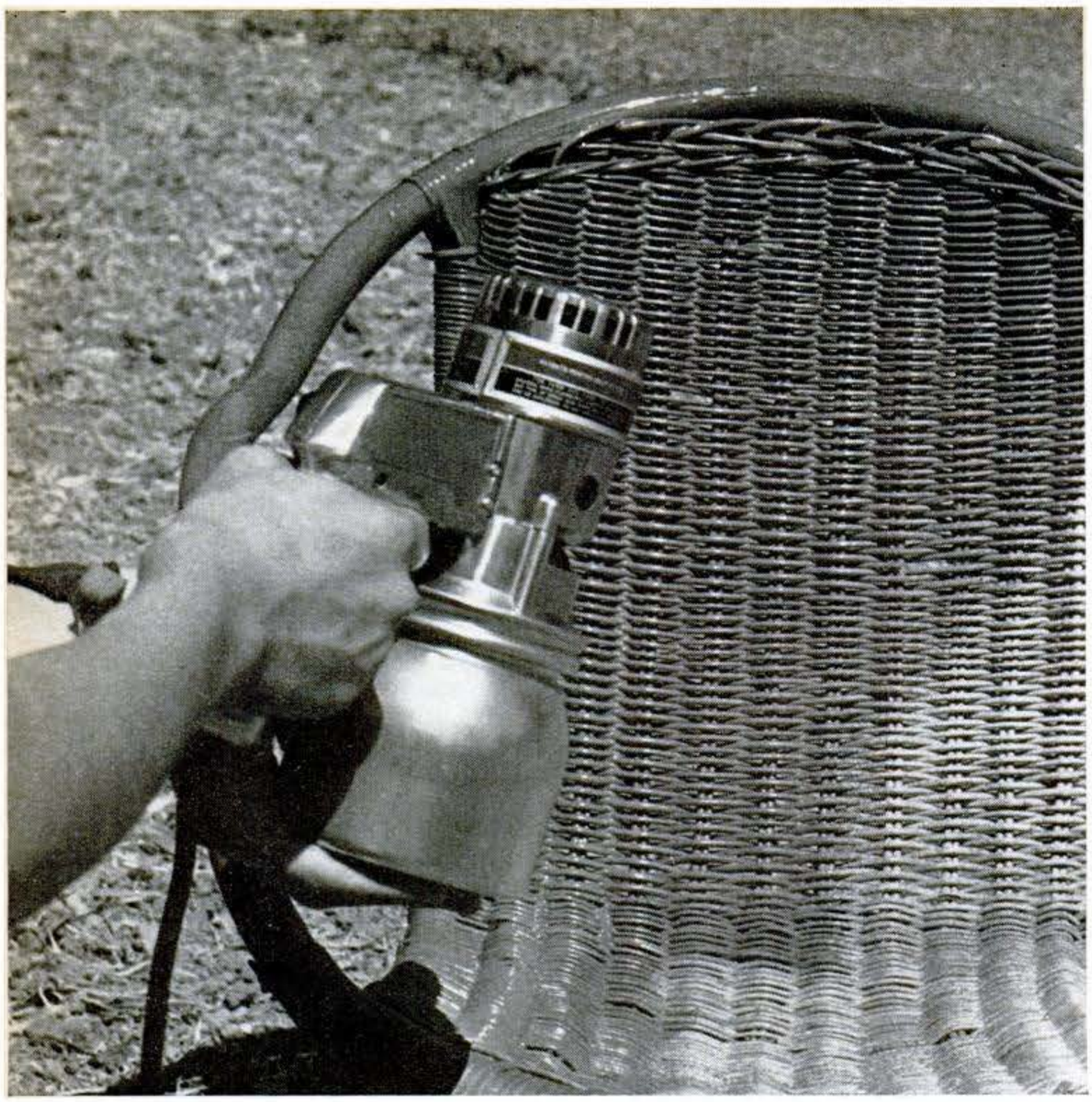
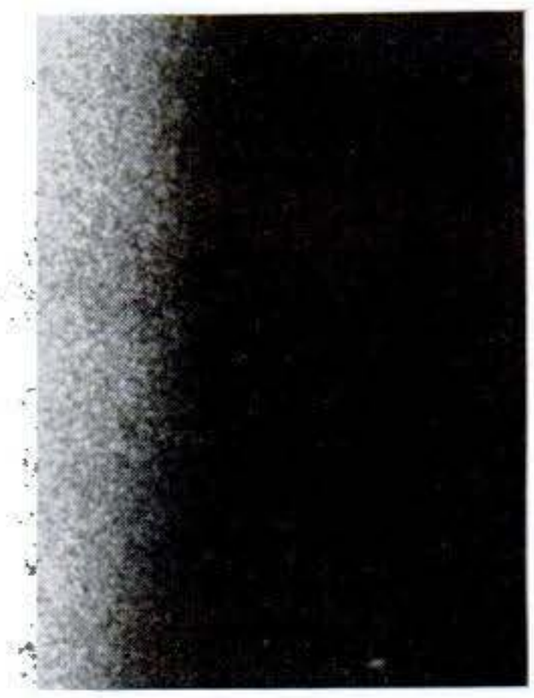


With the airless spray gun, you don't need to use those bothersome hoses and compressors.

Airless gun produces some overspray, but with noticeable lack of dusting and misting. Reduces need for furniture protection.



Conventional spray gun, misting and dusting, sprays a good six inches beyond the desired full-coverage area.

HOW GOOD IS THAT New Airless Spray Gun?

No hoses, compressors, or air to fuss with—but it doesn't replace an air-powered gun

By R. J. De CRISTOFORO

If you punched holes around the perimeter of a paint-filled flying saucer and twirled it like a top, you'd spew out particles of paint something like a Fourth-of-July spinning wheel throwing off sparks. Add adjustable gates to control arc length and you'd pretty much achieve what this airless spray gun does more tidily.

The concept permits a hold-in-your-hand unit, sans trailing hoses or compressors. No air—so no mist. Indoor painting requires minimal protection for furniture and adjacent areas. Overspray? Also minimized, but present, its extent controllable.

I think that novices, lacking prejudices, will be more successful with this gun than professionals or experienced craftsmen—but only after practice. You can do this with dye-tinted water or water-based paint. I tried the water thing and it's okay to start with, if only to get the feel of the gun. But paint is what you should play with before any this-is-it chore.

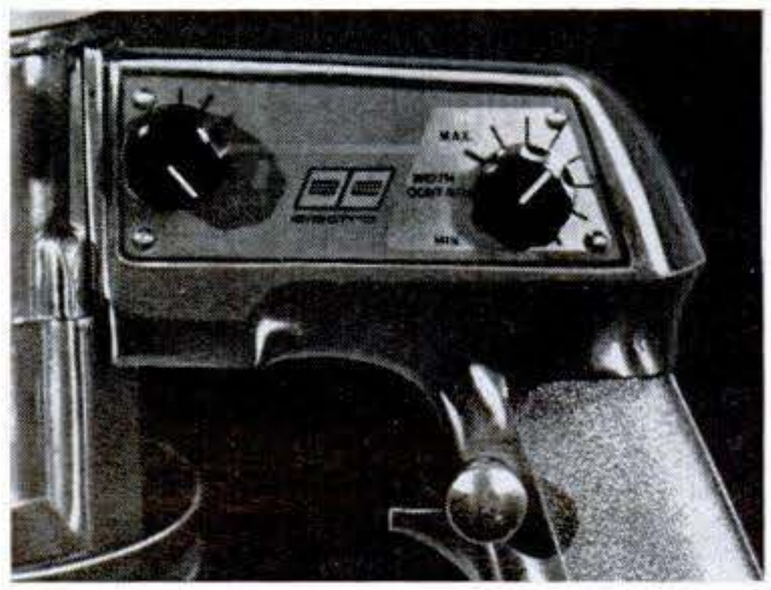
The gun is very nice to use on wall surfaces, because the horizontal spray can be set to cover a swath up to 18 inches wide. Thus it can be judged a practical maintenance item if you do your own painting. On wickerwork and similar stuff, I missed the air blast and the mist that rolls the paint around into crevices.

Since the width of the pattern is easily controlled, the gun can be considered for decorative applications you'd skip with an air gun.

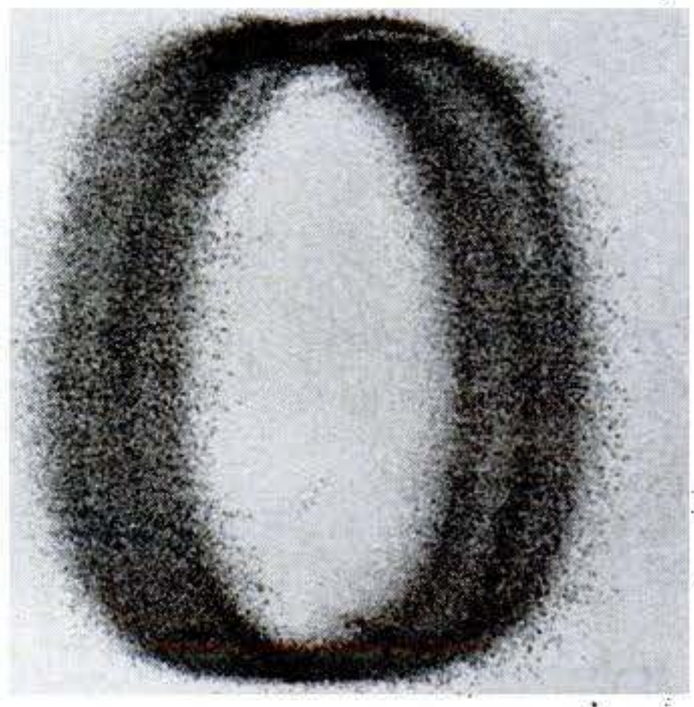
Gun cleanup is a chore, since it involves some disassembly.

The gun can be used for water-based paints, enamels, varnish—but not for lacquer. You can also do offbeat jobs like spraying fertilizers, disinfectants, and polishes.

The new gun is available by mail for $63.65 from American Products, 6322 No. Chicago Ave., Chicago. PS



Knob on right lets you select spray width, which can be changed as you work. Left knob is electronic variable-speed control.



Overspray control allows you to make patterns like this with airless gun. Freehand lettering and murals are possible.

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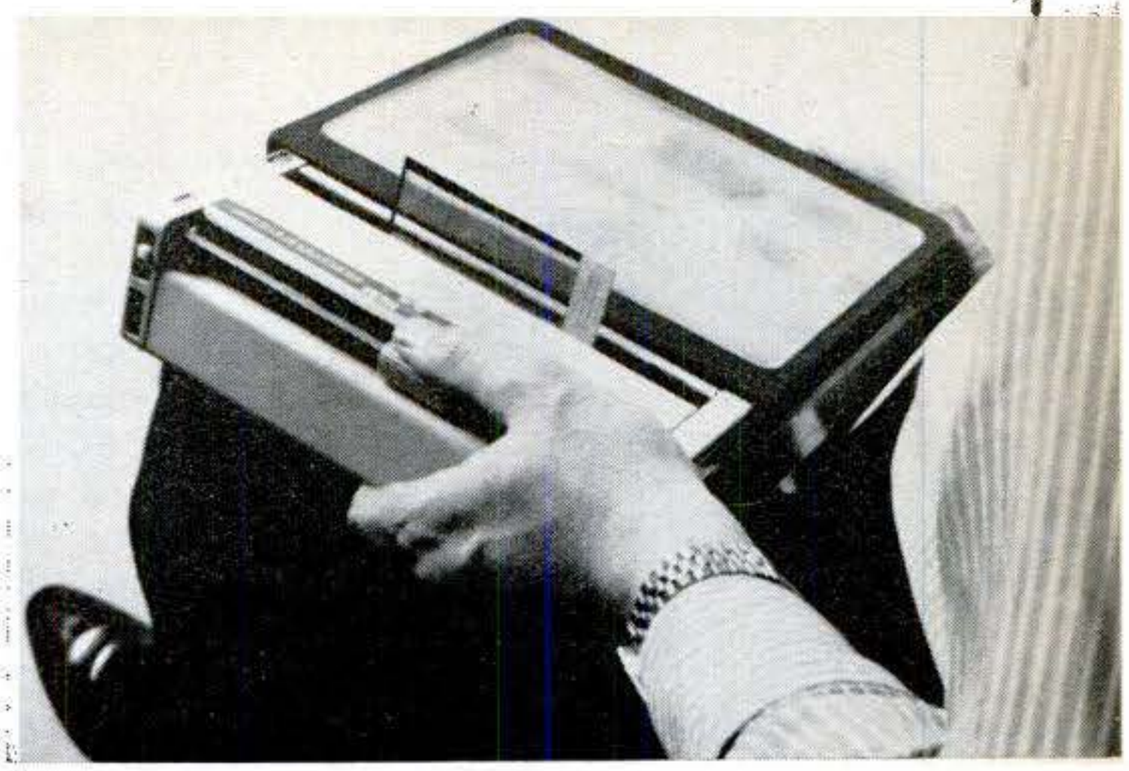
Pack This Portable Micro-Reader in Your Briefcase

Inexpensive, and easy to use, this microfiche reader could revolutionize your reading habits

By PAUL WAHL



Microreader is book-sized, weighs less than five pounds, and projects a bright image onto a 6½-by-nine-inch screen.

Imagine having a *400*-volume library in a shoebox—or carrying a whole year of POPULAR SCIENCE in your hip pocket with hardly a bulge! How? On microfiche, used in a handy new compact reader that you hold like a book.

What is a "microfiche"? *Fiche* (pronounced "feesh") is French for "index card" and that's about the size of it. Microfiche is like microfilm except that, instead of being on a roll, the microphotographs are arranged in rows on a four-by-six-inch sheet of film. For reading, the tiny fiche image is projected, greatly enlarged.

Currently, 60 or 98 images make up a microfiche, but I've seen as many as 3,200 pages satisfactorily reproduced on a single four-by-six film.

Today, micropublications include a wealth of reference material in all fields. However, the general public has been denied access to it—save in larger public libraries—for want of a suitable personal reader.

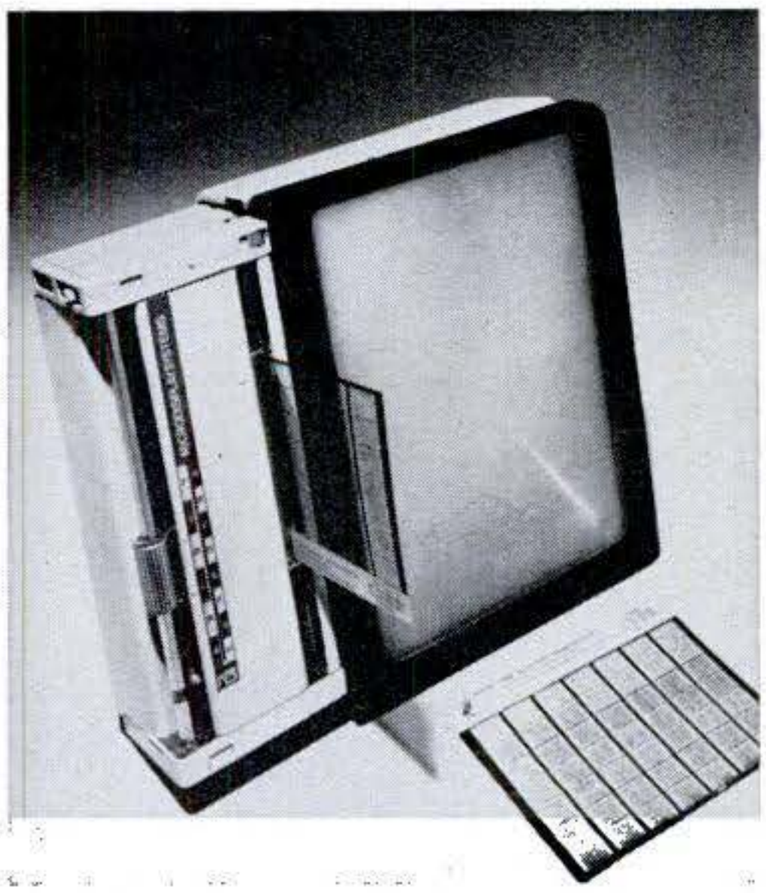
When George Margolin told me that his latest brainchild is the first book-size personal microfiche reader and that it will sell for under $150, he really aroused my interest. President of Microdisplay Systems, Inc., New York City, Margolin is a photo-optical wizard with an impressive track record, well-known in the industry. I had high expectations and this device exceeded them.

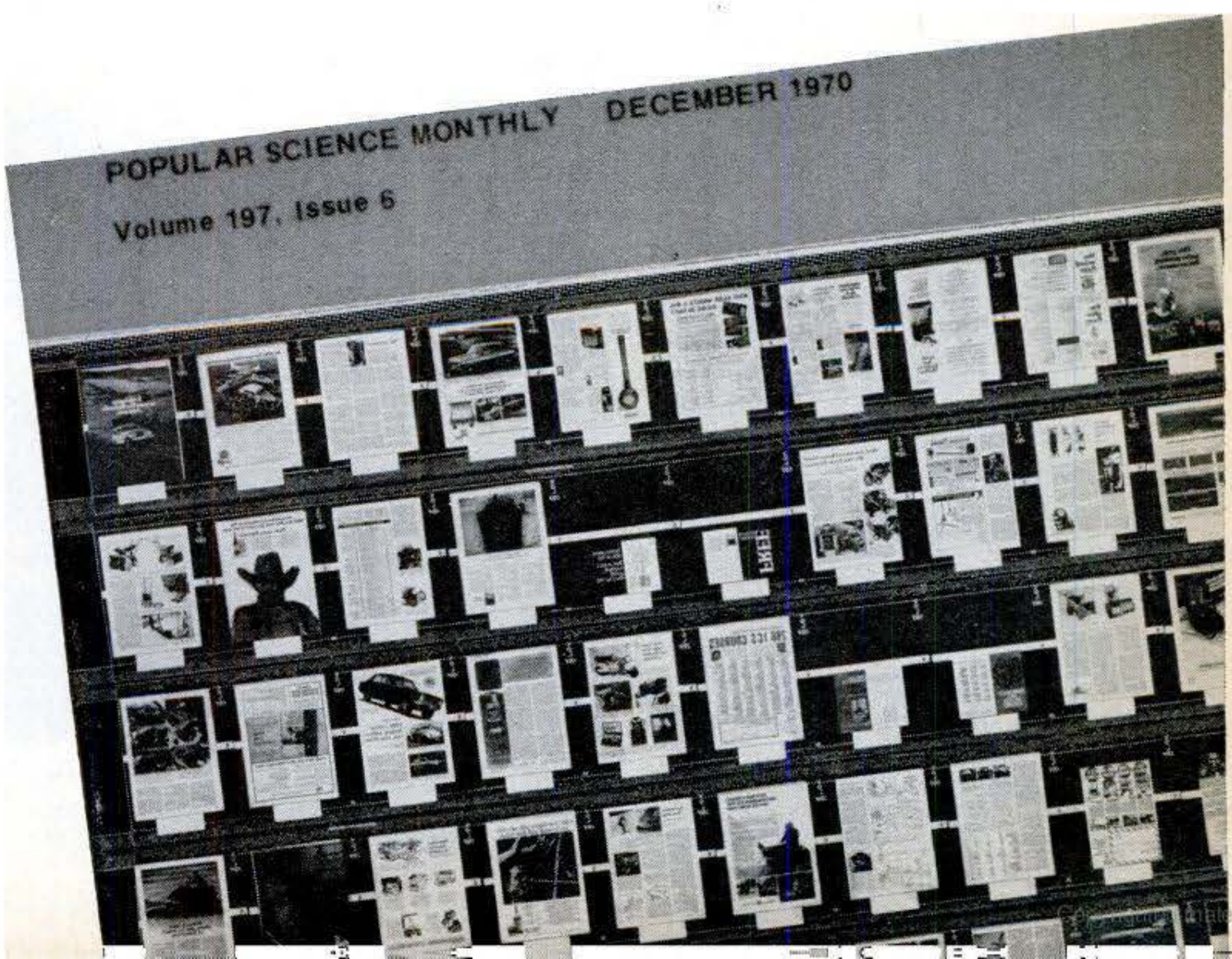
In storage position, with its optical head telescoped inside, the Microdisplay "Book-Size" Microfiche Reader is no bigger than this page and only three inches thick. It weighs less than five pounds. You can take this compact unit anywhere: It fits into an attaché case with much room to spare or can travel on its own shoulder-strapped holster.

Using this microfiche reader couldn't be easier. You pull the optical head out to its projection position, plug in the AC cord (it can operate from an accessory rechargeable battery pack too), switch on the 30-watt lamp, and insert the microfiche in its carrier slot. You can stand the reader on a desk or table, or hold it on your lap like a book. Focusing is by a fingertip lever. A single knob, operated with the left thumb, controls both image location and indexing.

An advanced optical system projects a bright, sharp, easy-to-read image magnified 18 to 24 times to fill the 6½-by-nine-inch screen with one page. Easily detached from the screen module, the optical head can also project an image on a wall for group viewing. Interchangeable lenses accommodate different formats and magnification requirements.

Microdisplay Systems will market this reader in late spring 1972. It might revolutionize the publishing industry. At a few pennies per copy, there's no cheaper way to produce a book or magazine than on microfiche. Availability of a modestly priced reader could make large-scale micropublishing practical. PS





Reader is fed microfiche cards containing microphotographs in rows on four-by-six sheet of film, 60-98 images per fiche. Right, part of PS microfiche in full size.

RUST REMOVERS: They Work

Those rust cutters do the job, but not if you follow the directions on them

By E. F. LINDSLEY / *PS Midwest Editor*

An old-time formula for household rust remover starts, "Dissolve one part sodium citrate in water, six parts, etc . . ." Happily, it's no longer necessary to plague your apothecary for potions to brighten the family armor. Today there are ready-made rust removers that promise to dissolve rust and bring back a clean fresh surface.

Do these rust removers live up to their promise? Not if you follow the instructions on the label. I tested a fair sampling of the rust removers on the market and none of them worked well when used in the "brush-on-wash-off" manner outlined in label instructions. But while I was testing, I came up with a procedure for using rust removers that *does* work. Follow me through my tests and I'll show you what I mean.

For an initial test I dug out an old carpenter's square. It was covered with 60 years' accumulation of rust. Number markings were nearly unreadable.

Following directions, I wiped off surface dirt and coated six areas of the tool with six different rust removers. Then for 30 minutes I puttered around the shop patiently awaiting the moment to wash off the removers in plain water—as advertised—and view the gleaming results.

The wash-off was a washout. Although there were, here and there, scattered patches where original numbers and scales showed up fairly well, for the most part very little of the ancient rust had been removed.

What went wrong? A little analyzing showed that the rust I wanted to remove was more than simple iron oxide. It was a veneer composed of rust, workman's sweat, cutting oil, jackpine pitch, and linseed oil. So I'd learned a lesson: What appears to be rust may be something quite different, even though rust serves as a binder for the whole mess.

Tucking that piece of information in the back of my mind, I turned to a test on some more-modern rust. Out in the driveway, I brushed a liberal coat of Dow Rust Patrol into a rust spot on my car's rear deck. Hopefully, the foamy white cream would leave a clean surface I could spot with primer and touch-up paint. With a brisk wind nipping, and temperature below 50, I ducked into the house to let the remover do its work.

The rust was still there 30 minutes later, encapsulated in a gob of dried, gummy rust remover. Obviously the cold had inhibited the chemical action, and the wind had dried up the chemicals needed to produce the action. I'd learned another lesson: Successful rust removal is a matter of recognizing the nature of the remover and then providing conditions that let it do its work.

I decided to try "fresh" rust again. A breast drill, inadvertently exposed to water in the basement, was covered with rust. To eliminate any oils, grease, or wax that might block penetration, I flushed the drill with lacquer thinner and blew it dry with compressed air. Then I brushed it with remover, reapplying as needed to keep the surface wet for an hour.

Mixed results. The rinse-off revealed some lightly rusted areas now clean, but other areas seemed to have a dark, crusted covering. Disappointed, I set the drill on top of the furnace boiler to dry.

Here I made another mistake. The next day the drill was a mess with white powdery deposits. The gears and chuck were locked up. Lesson? Wash de-rusted parts in hot water and detergent, brush vigorously, and dry carefully. If you can disassemble, do so. Rust removers tend to creep into bearings and working assemblies.

In an attempt to rescue the drill, I gave it a going-over with a wire brush. To my surprise the dark crusted areas came clean—under the lightest kiss of the brush.

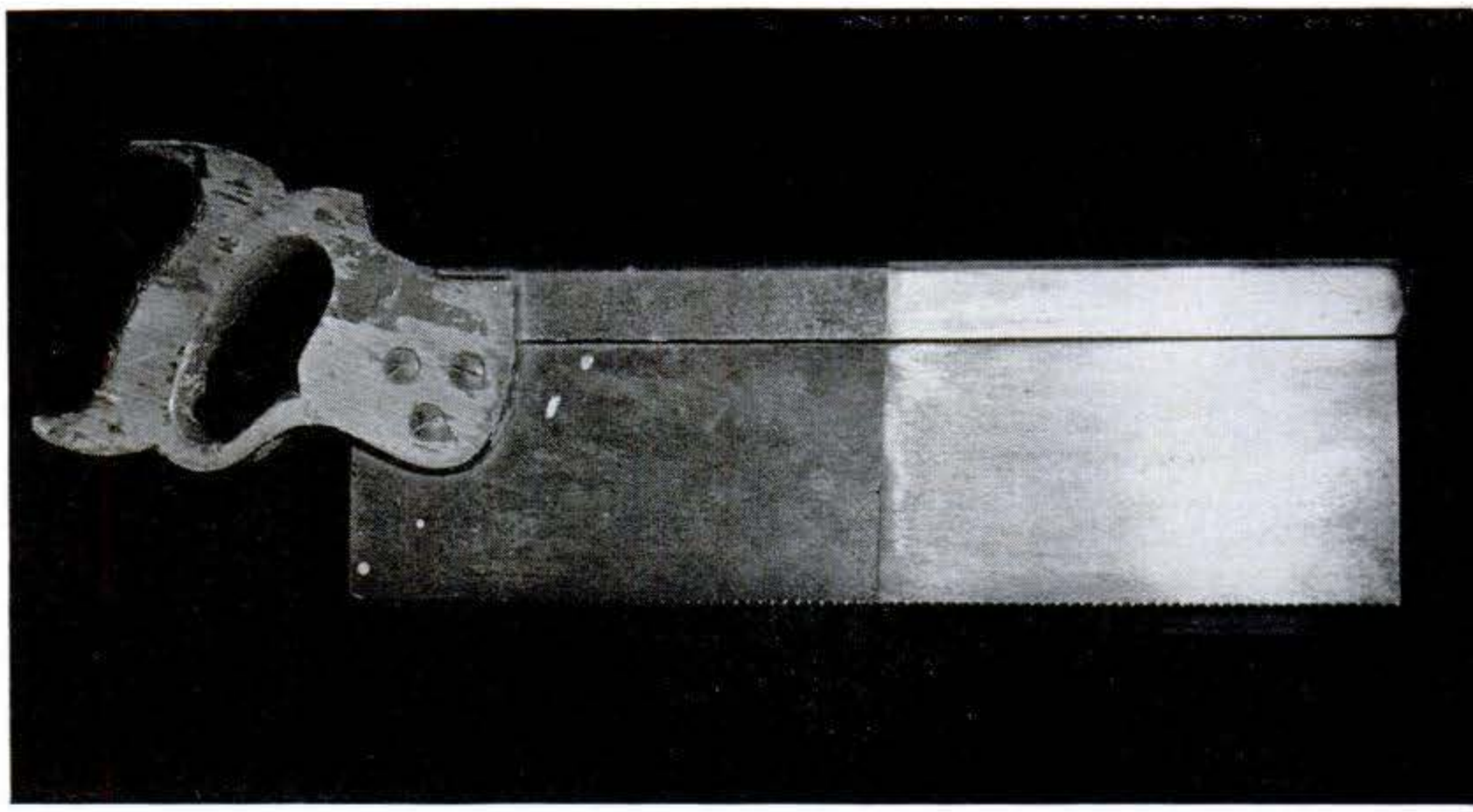
Putting it all together. Now I was onto something. I decided on a final test, using everything I had learned. A box hidden under my workbench held a collection of drills, taps, and small tools, all in disgracefully rusted condition.

Figuring that the dark patina on these tools was more than simple rust, I soaked the tools in lacquer thinner. Then, at room temperature, I wallowed a few of the tools in an old photo tray with rust remover a quarter-inch deep in the bottom. To assure sustained contact, I periodically brushed on fresh remover.

After 30 minutes I lifted out each tool and hit the really bad areas with #240 wet-or-dry sandpaper. Another 30 minutes of soaking, brushing, and wallowing was followed by a thorough flush in hot water and detergent.

Results? The tools were remarkably clean. Here and there a few dark barnacles remained, but I found they could be flicked off with a thumbnail. The surfaces of the tools were dull and gray, but I expected that. And, as expected, the wire brush brought up a bright, factory-new finish on each of the tools. I had finally developed a system that let the removers do their job.

Summing up. I learned that the key to successful rust removal lies in how well you take advantage of the ability of the rust-removing chemicals. There may be other removers on the market



Rust really disappears when you use rust removers carefully. Tip half of this back saw was given the Lindsley treatment, the other half the brush-on-wash-off treatment outlined on rust-remover label. Label procedure left rust almost as it found it.

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If You Know How to Use Them

that work in other ways, but for the acid-etching type I tested:

- Precleaning to allow the remover to reach the rust is critical.
- Dabbing on a thin coat isn't enough. Parts must be kept wet.
- Intermittent sanding or rubbing with steel wool does wonders.
- Two hours' soaking time is usually required for heavy rust.
- Casual rinsing leaves messy deposits. Thorough washing with a brush is a must.

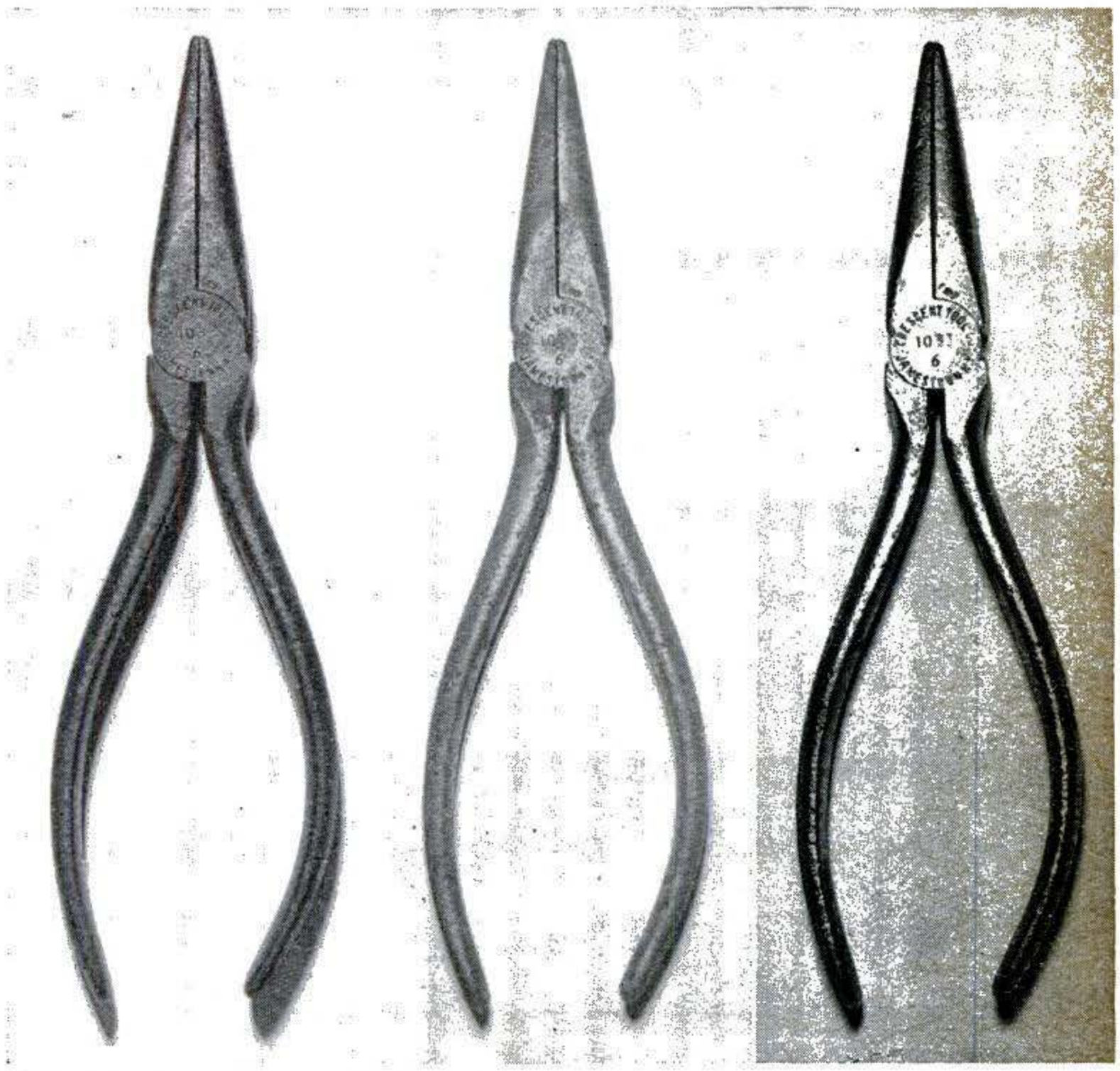
Which remover worked best? Truthfully, the six tested seemed to work about the same. Some tend to run off vertical surfaces faster than others, but this turns out to be unimportant, since all six require repeated stirring and reapplication anyway.

Some claim to leave a protective film behind to prevent future rusting. If this is true it's hard to detect, especially after a good detergent washing.

All removers leave the metal with enough "tooth" for good paint adhesion unless you intentionally brush and buff for a bright finish. Don't expect to remove pits and scars. Metal that is gone is gone forever.

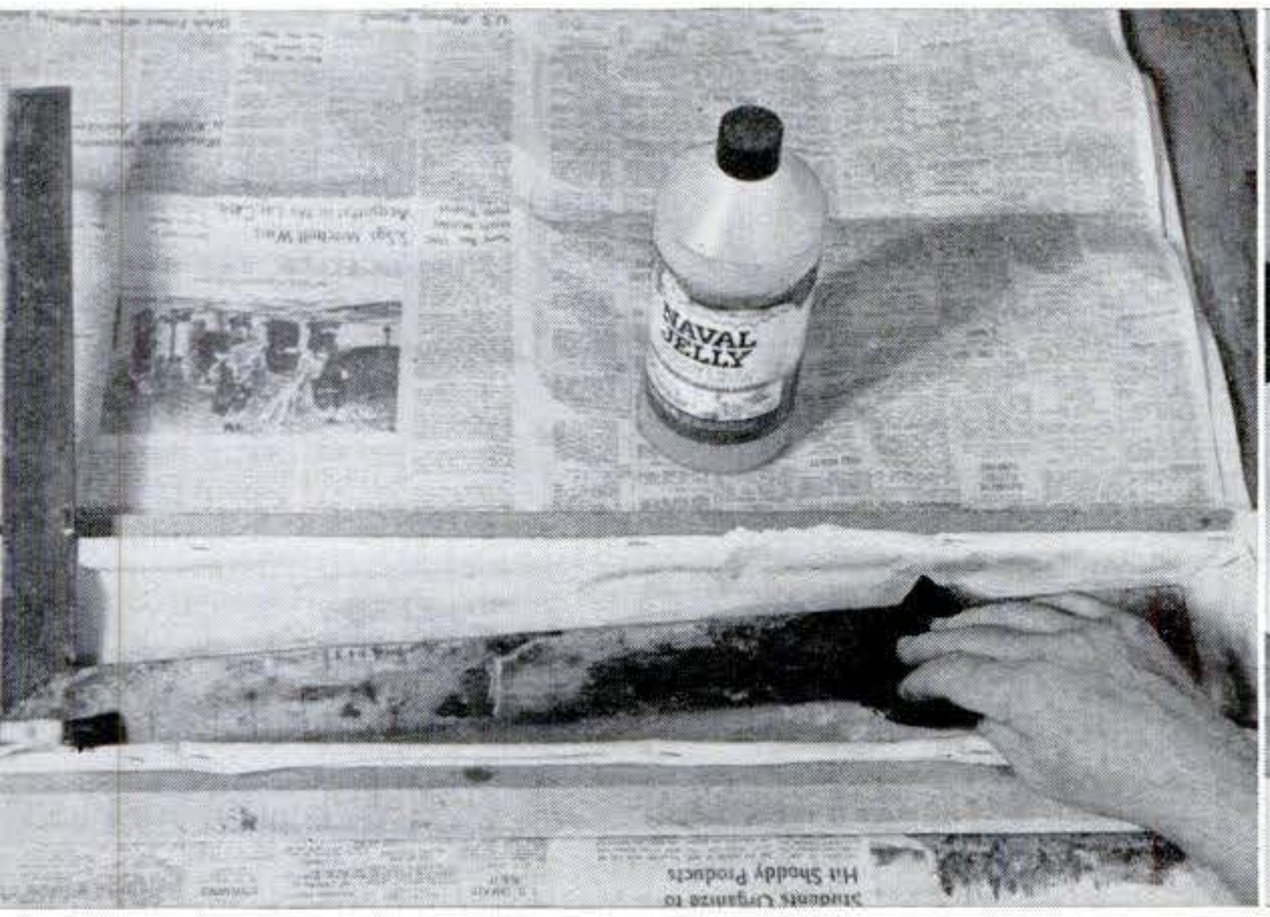
Some removers, such as Rust Patrol, claim they won't harm paint; others warn that they will. In my tests, none seemed to hurt paint, but this may be due to the nature of the paint rather than the rust remover. Here I'd believe the directions.

None, as far as I could tell, seem to burn the skin or give off irritating fumes. All sting, however, if they get into cuts, so it's a good idea to wear rubber gloves, at least during the sanding operation.



Three stages of rust removal start with a badly rusted tool, above left. After the Lindsley treatment (precleaning in lacquer thinner, continuous soaking for an hour in rust remover, occasional stirring and hand sanding), pliers are clean but dull (center photo). A light wire brushing brings up the gleam of bright metal (above right), but note that pits, scratches, and scars remain Rust removers can't restore lost metal.

Warning: Most removers tend to discolor chrome. If you plan to use them on car bumpers or trim, try an inconspicuous spot before going all out. In fact, best advice on any rust-removing job is to try a few experimental spots and work out a technique that's suited to the nature of the object you're going to clean. And do the job at room temperature. PS



Key to effective rust removal is constant contact between chemicals and rust. Soaking—as in this wood and plastic trough—helps. So does periodic sanding if rust is heavy.

Six different rust removers—Naval Jelly, Rust Patrol, Jelly Derust, Rust Jelly, Liquid Gel, and Kutz Rust—were tested by author. All seemed to work equally well.

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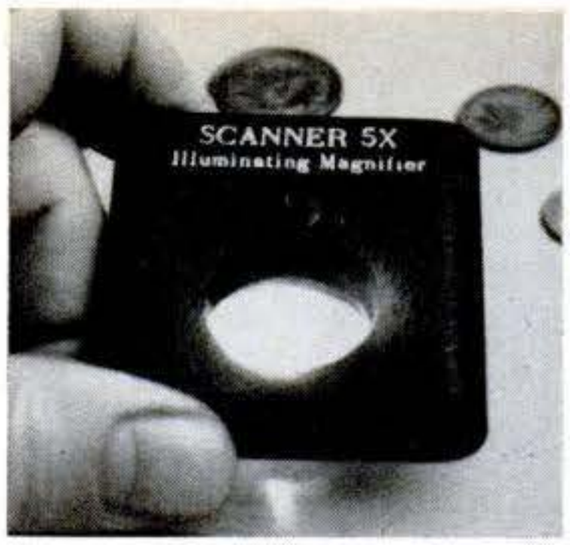
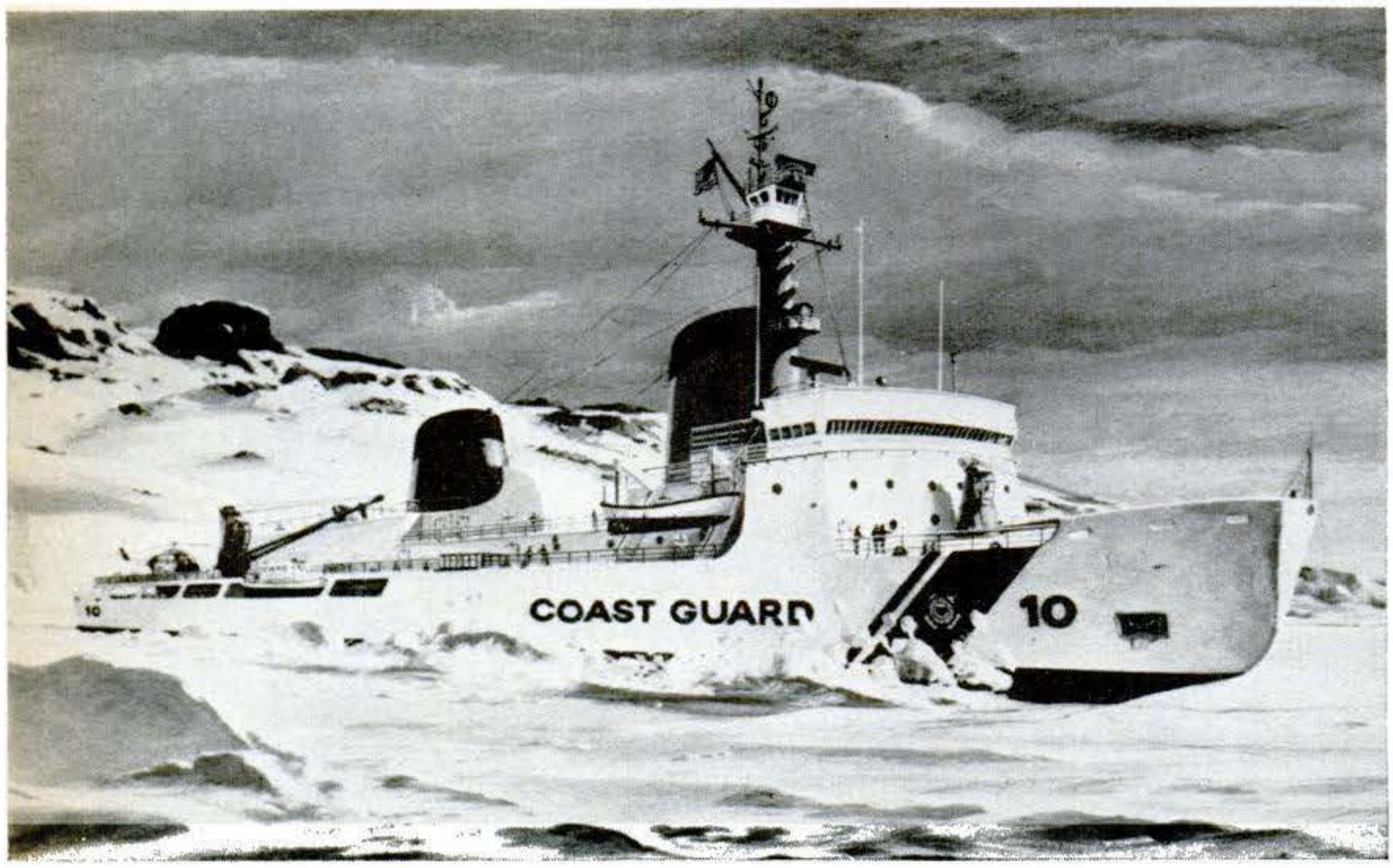
What's New

A PICTURE ROUNDUP OF NEW PRODUCTS AND DEVELOPMENTS



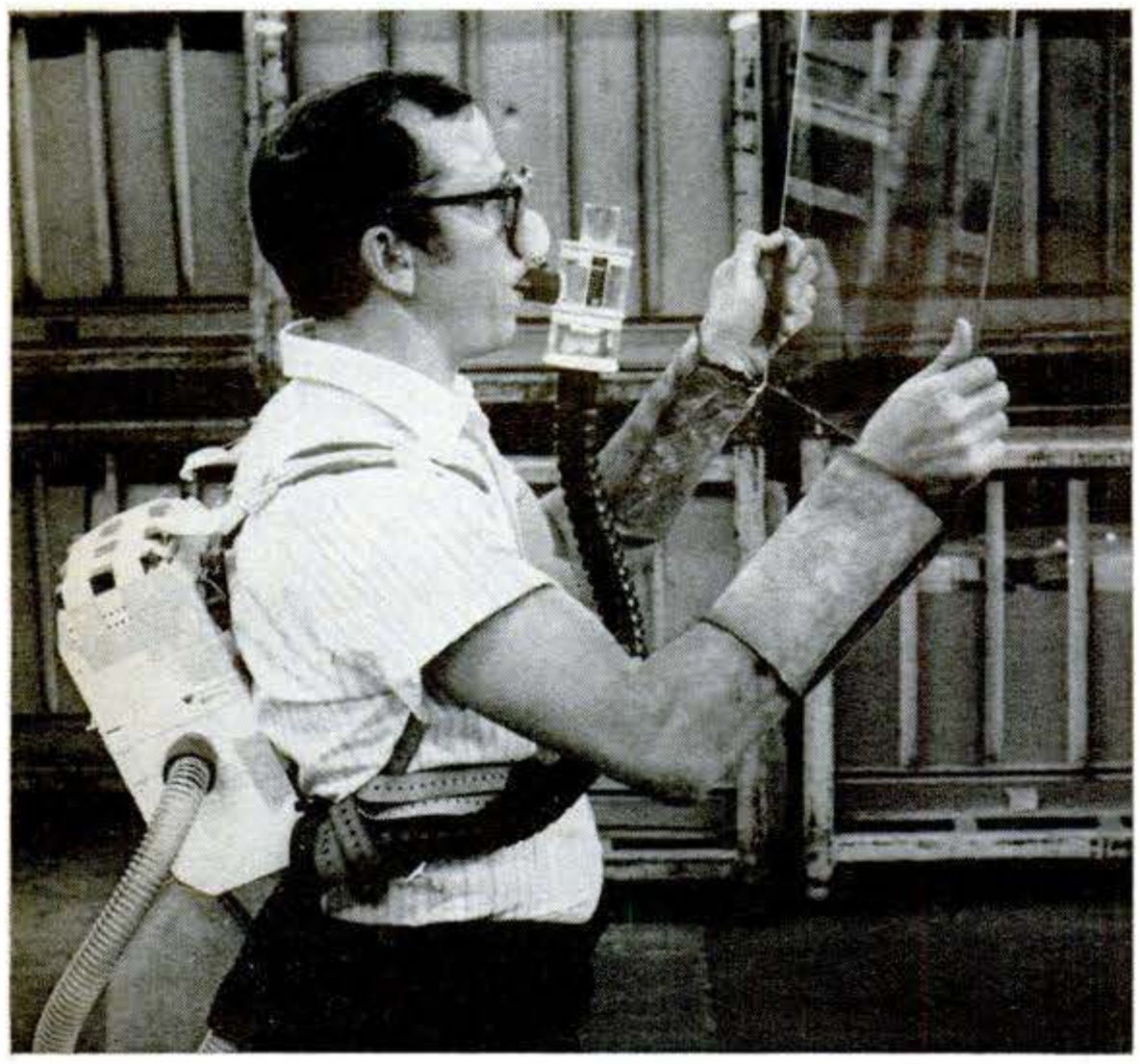
Light-up magnifier

Stamp and coin collectors will like the Scanner, a magnifying glass with a light built in. It comes in five or 10 power, and weighs only two ounces. Price? $3.95 for 5X and $4.95 for 10X, batteries and bulb included. From Flex Electric Products, 40-14 24th St., L.I.C., N. Y. 11101.



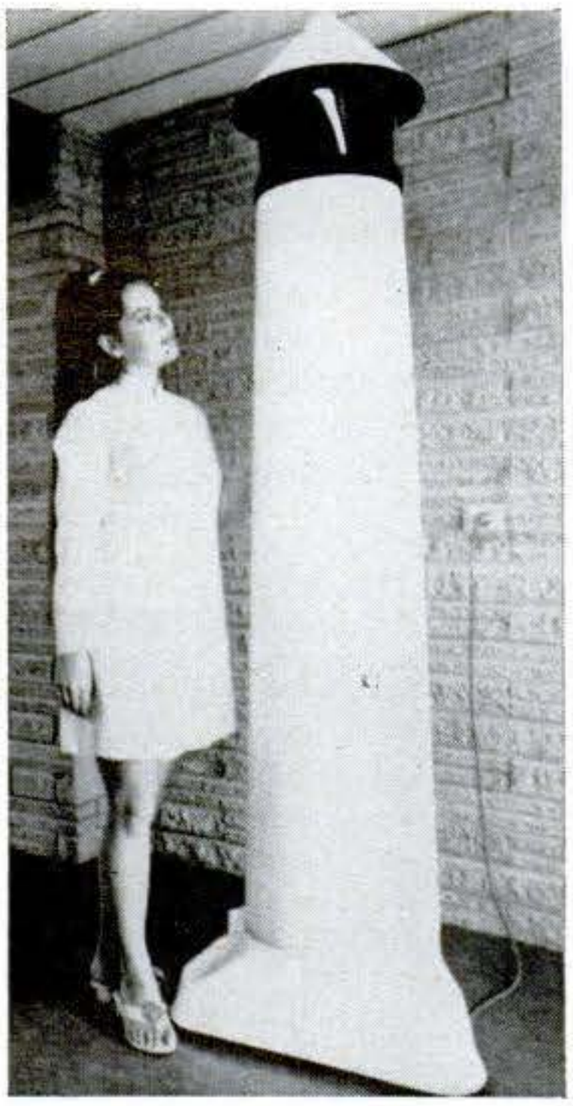
Big icebreaker

This 400-foot, 12,000-ton Coast Guard ship will be the world's largest and most powerful icebreaker, ramming through ice up to 21 feet thick. When completed in 1974, she'll carry 155 men, 10 scientists, and two helicopters. Cruise speed: 13 knots. Range: 28,275 miles.



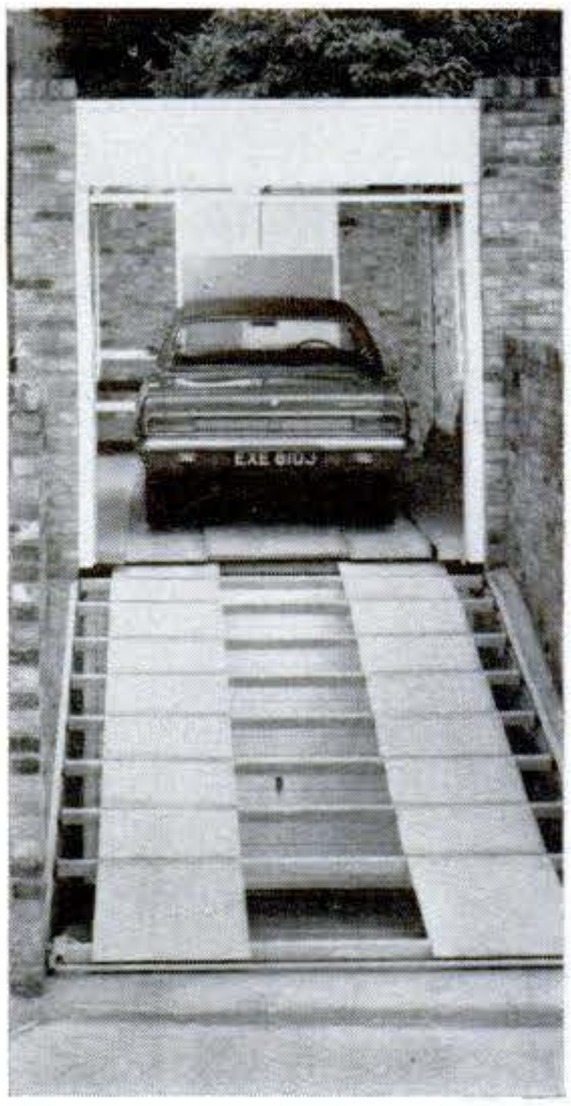
Breathtaker measures physical stress

Ever wonder how much heat you give off during normal working hours? Environmental-controls engineers have. The instrument above measures the body's metabolic rate during work. The worker breathes into a tube connected to a backpack, which collects exhaled air for measurement of oxygen depletion caused by physical exertion. The experiment is part of a study by Pittsburgh Plate Glass to determine if there is excessive heat stress in occupations near melting tanks and blast furnaces.



Laser lighthouse

You're looking at the world's first laser-beam lighthouse, located at Point Danger, Australia. Atop a monument 146 feet above sea level, it's 7½ feet high. The light beam is visible for 22 miles out to sea and uses only 200 watts of electricity. Operating cost is a third that of a conventional lighthouse.



Split-level garage

Have two cars and room for only one? This space-saver houses two cars in the width of one. The lower car is 3¼ feet below ground; the upper car space has a steel ramp that rolls out on guide channels like a rolltop-desk lid. Want one? Barron & Shepherd Ltd., 134 King St., London W6, England, sells it for $2,250.

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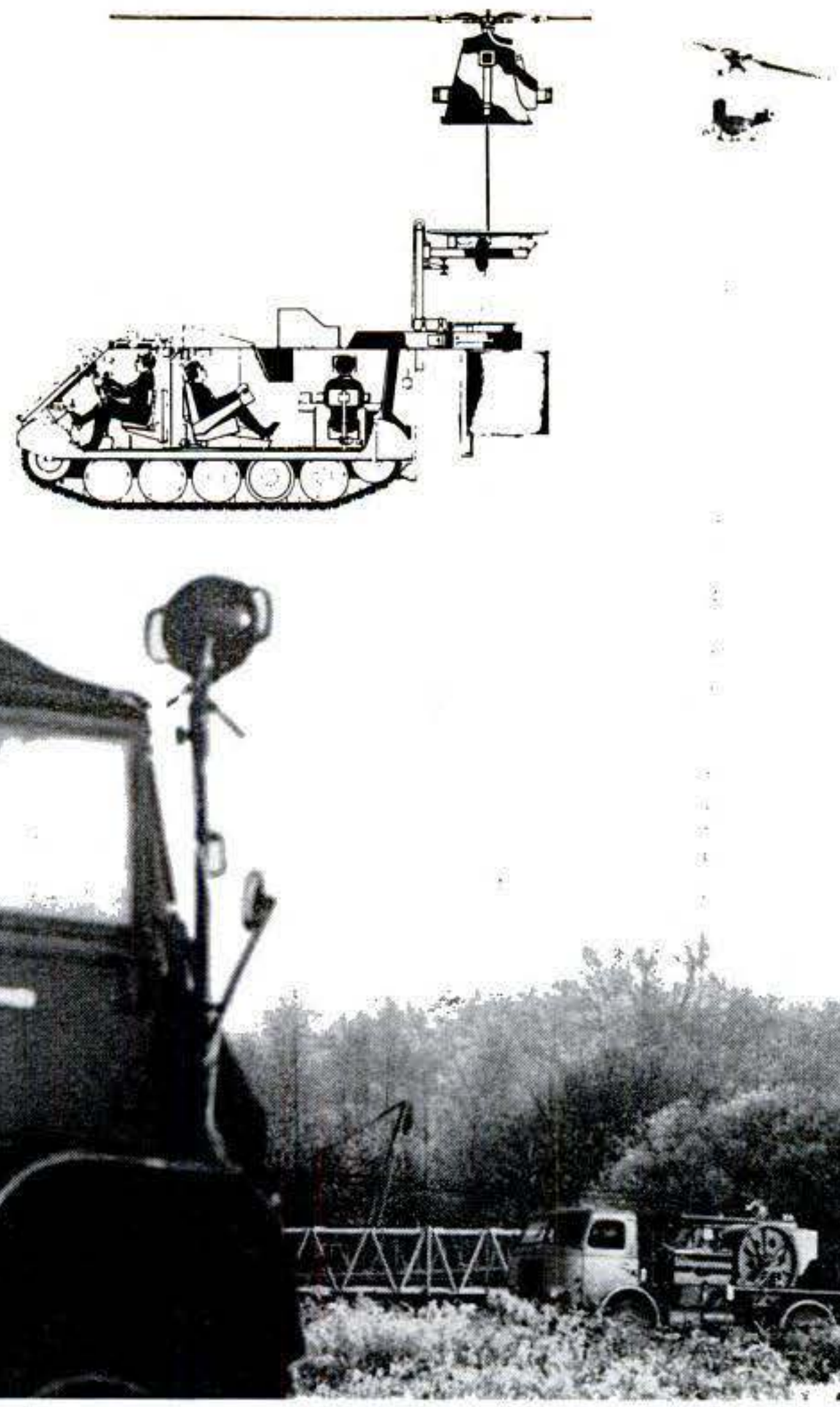
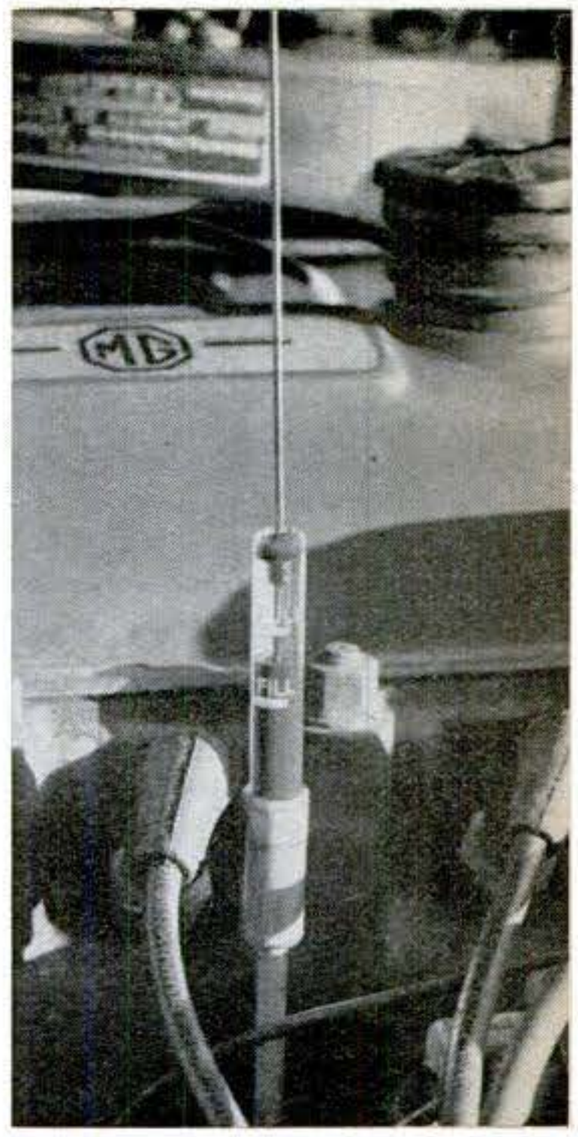
Call holder

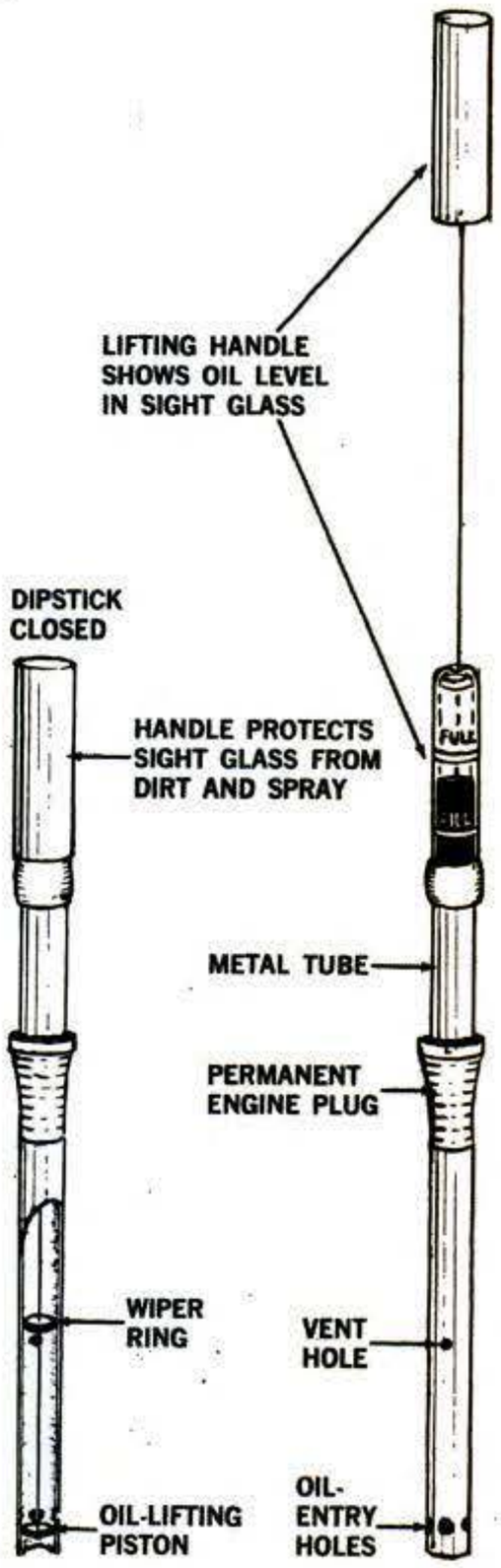
You no longer have to cover the mouthpiece of your phone when you're checking a call with a third party. Hold-On Cap holds the call so you still listen, while the receiving party can't hear you. You just flip a lever. $5.20 from Hammel, Inc., 15 Fifth St., Closter, N.J. 07624.

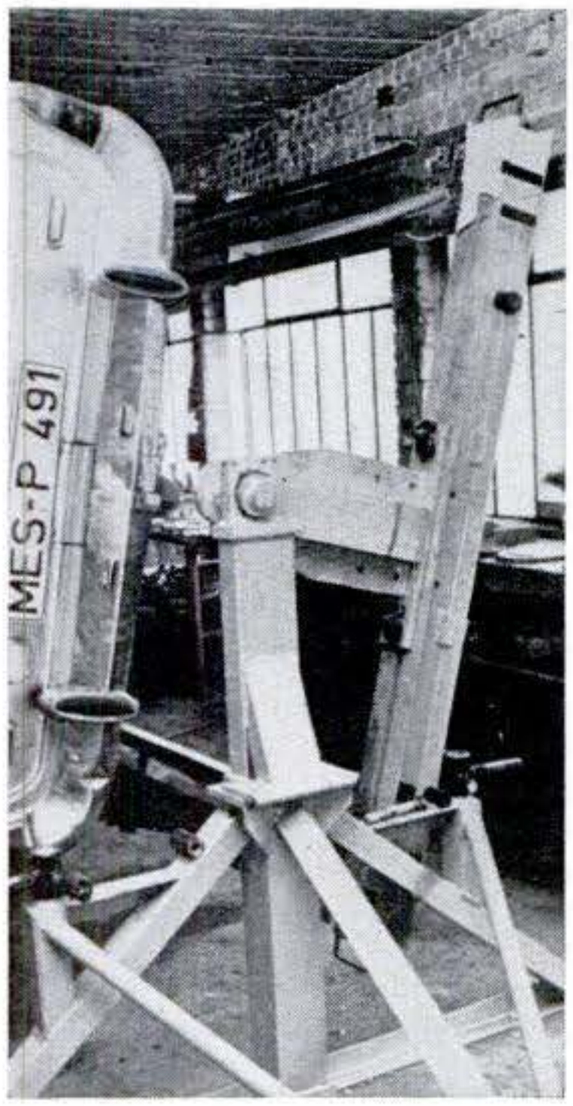


Tethered copter

Nobody's up there in that tethered copter, an experimental design by Dornier of West Germany. The "auto-stable platform"—which automatically keeps station over the control vehicle—gets its fuel and directions from below. The system is designed for military use.

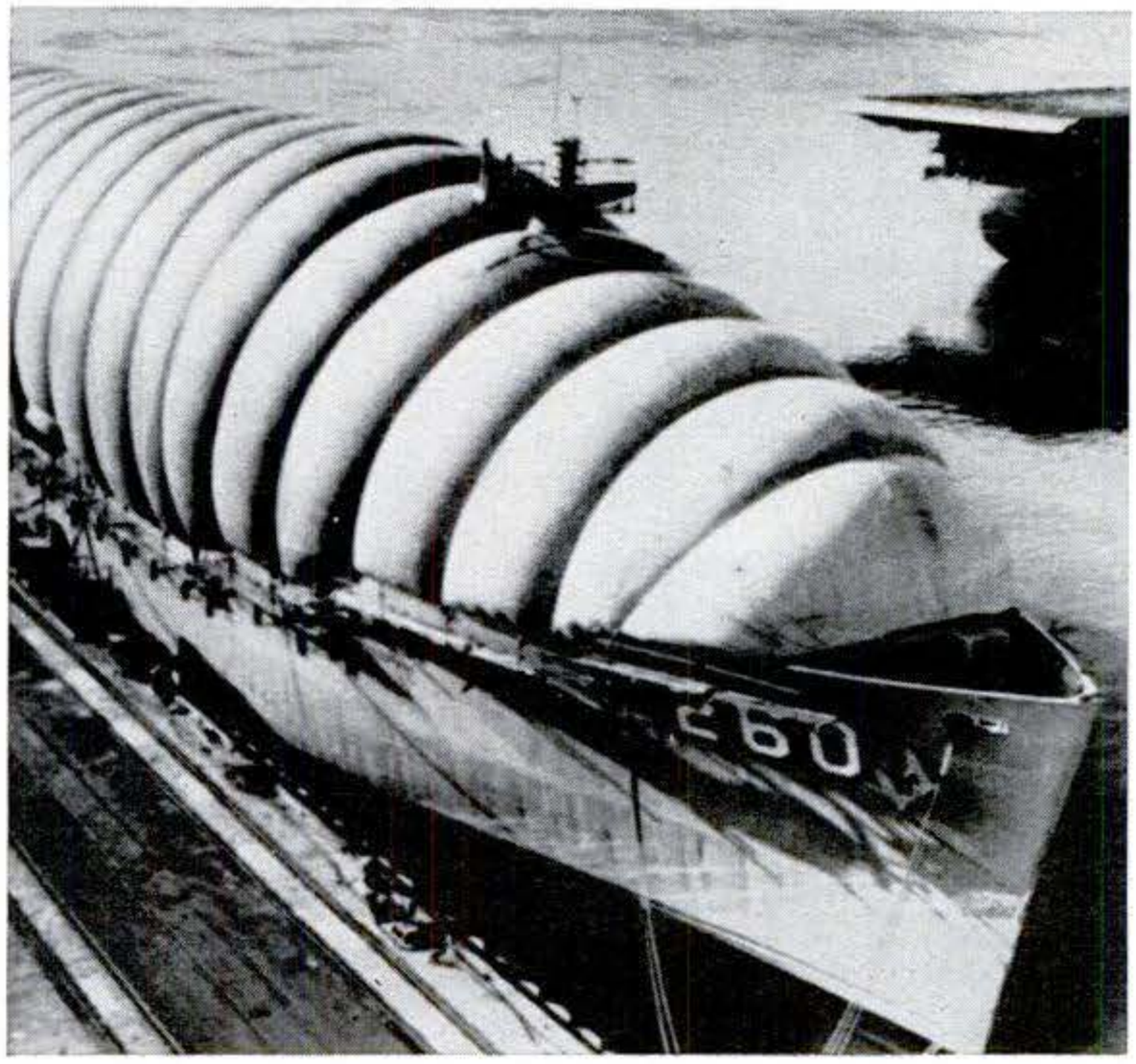






Rotating ramp

Auto mechanics need no longer work on their backs or strain their necks with overhead hydraulic lifts. This German rotating ramp turns a car up to 90 degrees so that repairs underneath can easily be made standing or even sitting. Inventors are two mechanical engineers from Dortmund.



Caterpillar is really a mothball

Giant monster eating a battleship? No—it's the Navy's newest experiment with easier ways of preserving inactive ships. Shown above is the attack cargo ship USS Betelgeuse with an air-inflated, plastic-treated cover. The caterpillar-like dome keeps dehumidified air circulating through the ship, reducing the time and work needed to deactivate, or reactivate, the vessel. The dehumidified atmosphere also helps to preserve the ship's abovedeck equipment.

Automatic dipstick

Now there's a no-mess dipstick. This English device has a metal tube with a small piston attached to a wire cable. When the cap is withdrawn, the piston pulls up a slug of oil that is visible in a calibrated glass cylinder. You can also examine the condition of the oil.

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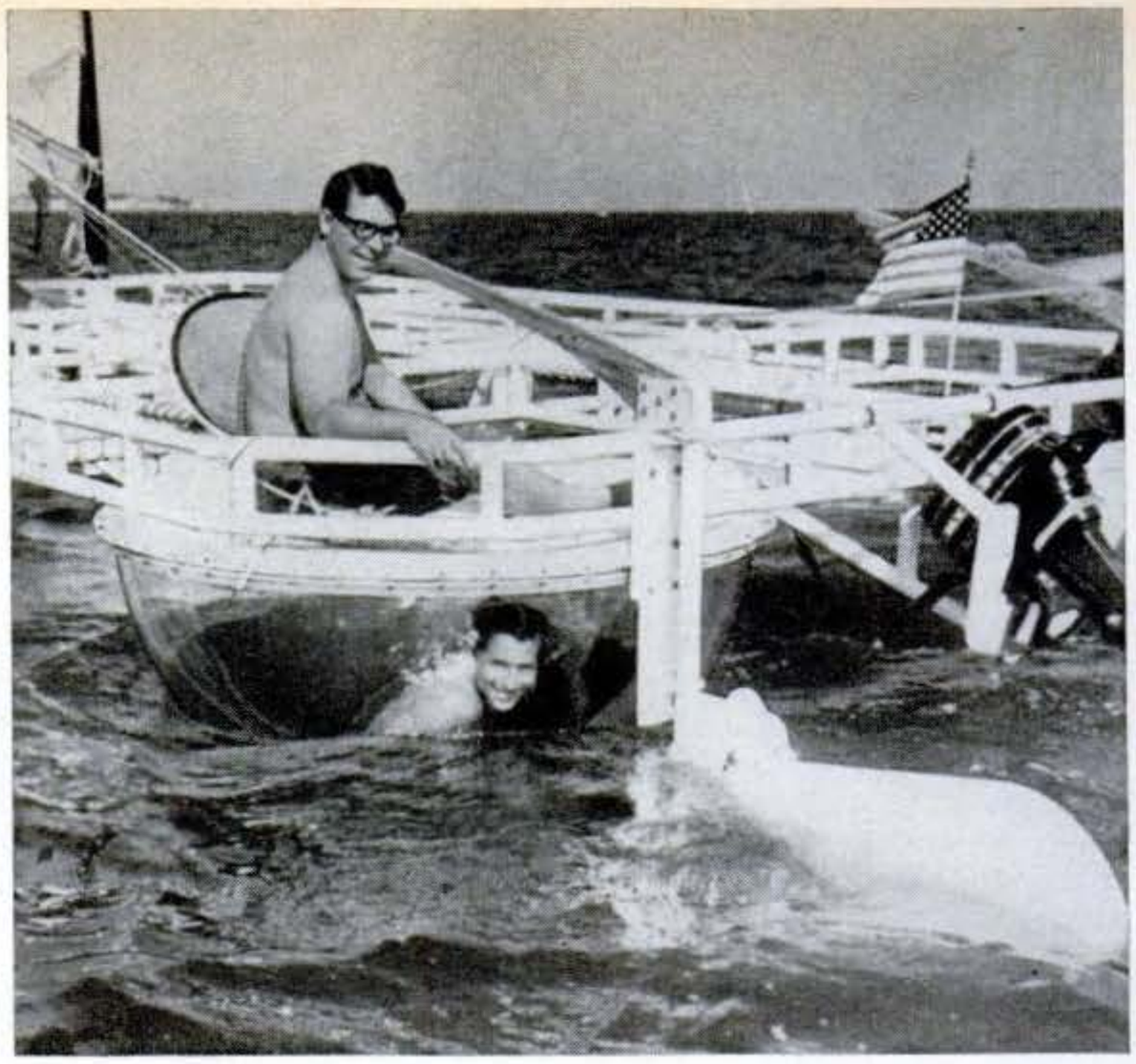
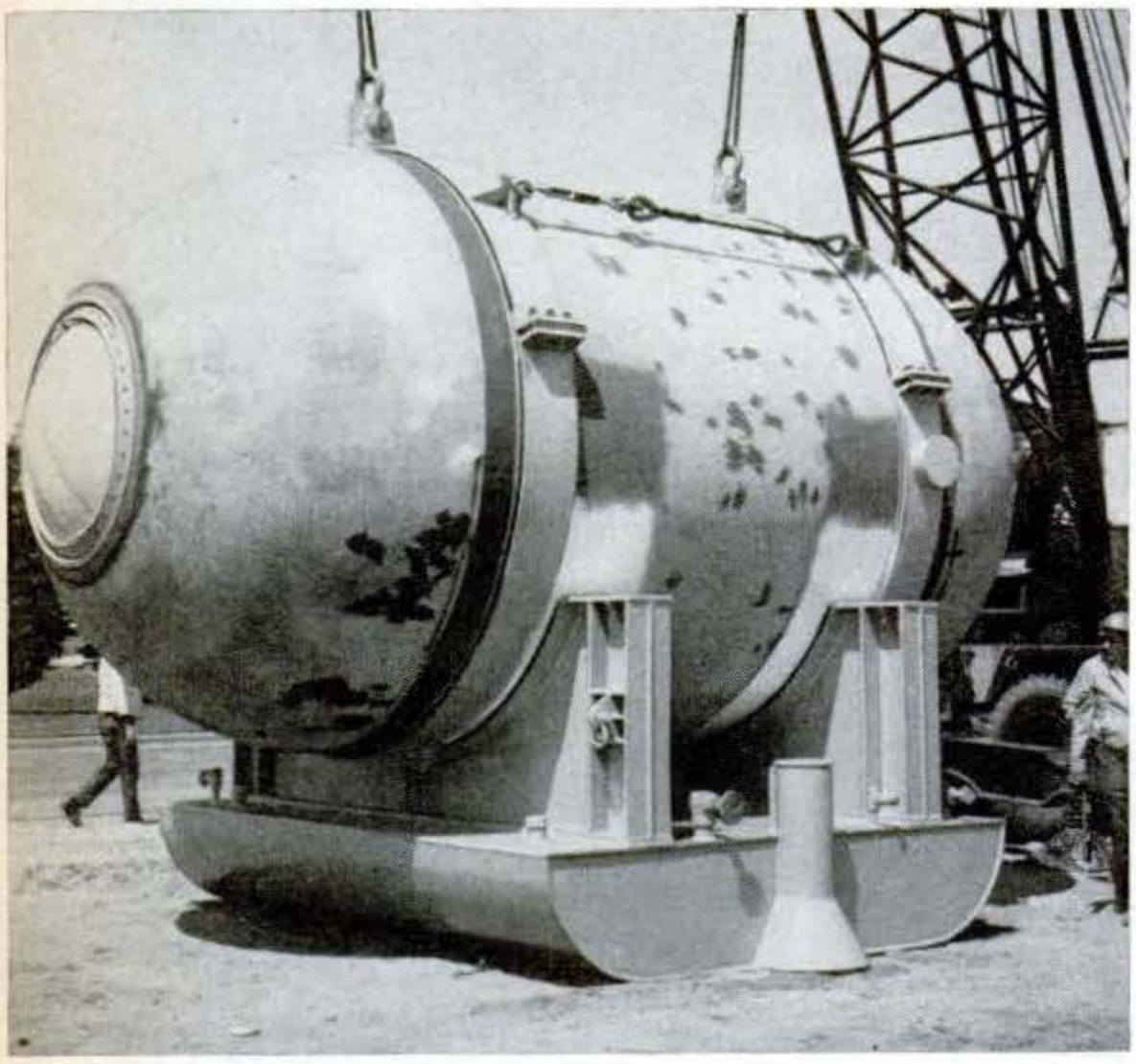
What's New

Bubble-float boat

Four hemispheres, six feet across, keep this experimental boat afloat. Made from polycarbonate, the material of Apollo helmets, the hemispheres were built to test their optical properties. The boat? An idea to check out the bubbles for oceanographic use. It's by Air Lock, Inc., Milford, Conn.





Seagoing cylinder

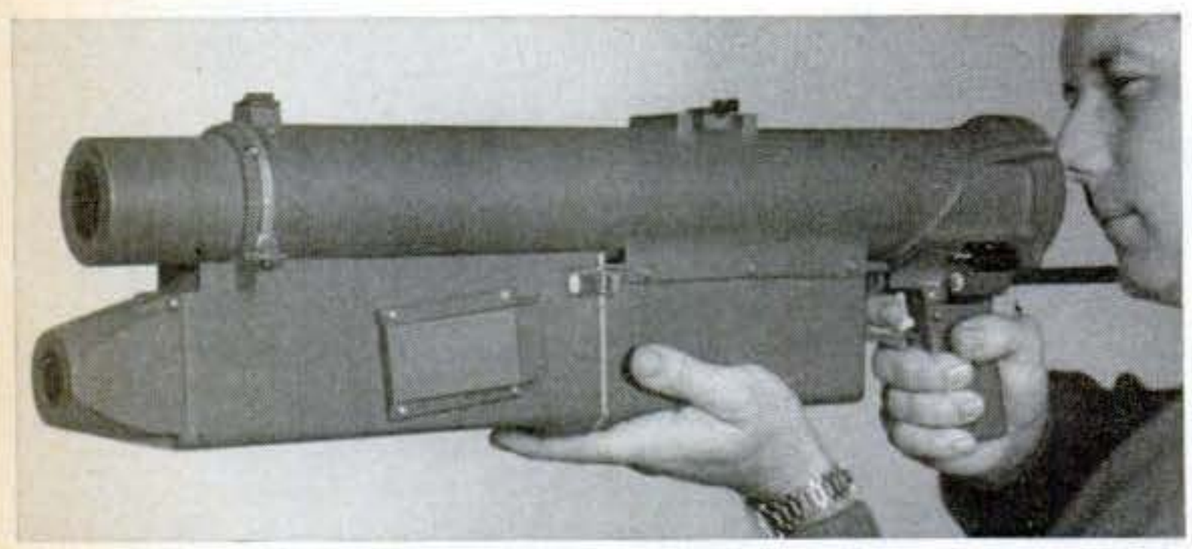
The 90,000-pound unmanned concrete cylinder at left is shown before the Navy placed it on the ocean bottom at 600 feet. The SEACON (Sea-Floor Construction Experiment) structure is 20 feet long, 10 in diameter. Closed-circuit TV provides info by scanning through acrylic nose window.

Sport coupe

Now Fiat has introduced a 128 sports model in addition to the boxy sedan [PS, Sept. '71]. The new coupe comes with a 67-hp engine (vs. 55 in the standard model), which gives a true 90-mph top speed. The SOHC engine sits transversely driving front wheels, giving ample room for four riders.

Ticket puncher

No fumbling for coins or checking of tickets with this Swedish device—as you board a bus or train you just shove your commuter ticket in. The machine examines the ticket to make sure it's not outdated or phony, then punches and stamps day and time. It saves work for the driver, fuss for the commuter.



Laser pinpointer

Handheld or mounted on a tripod, the laser designator at left enables a forward military observer to pinpoint a target with a laser beam, for laser-guided missiles or laser-sensitive tracking devices. Below the barrel-shaped designator is a receiver, for accurate ranging up to five miles.

Fastest boat

A little boat with a lot of engine—that's "Mr. Ed," first quarter-mile drag boat to top 200 mph. World mark of 202.46 mph was set at the Drag Boat Assn. Nationals, Long Beach Marine Stadium, Calif. The boat, owned by Ed and Lorene Wills, was driven by Larry Hill.

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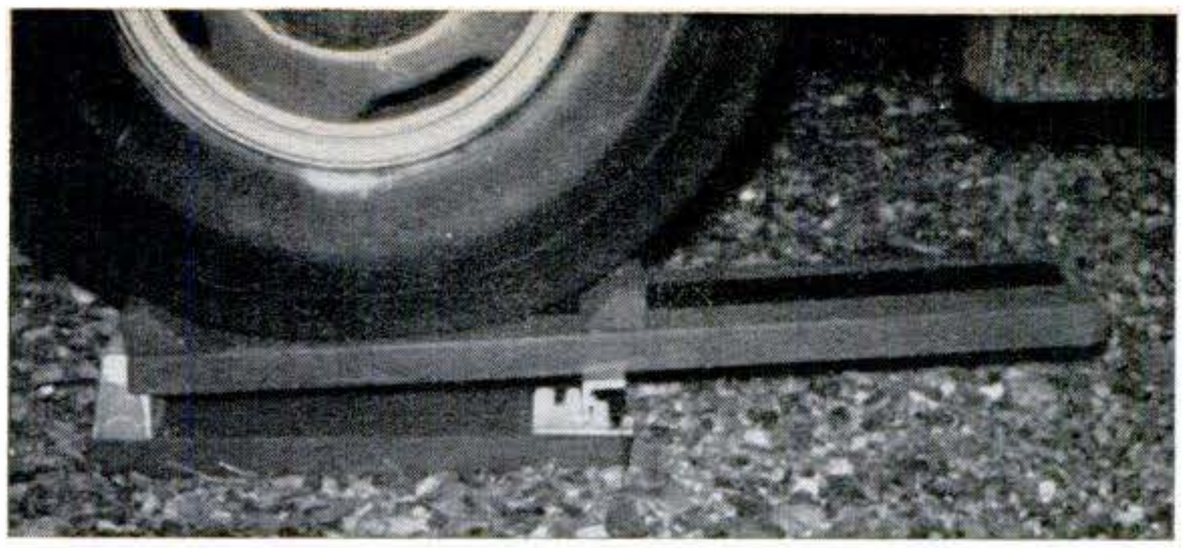
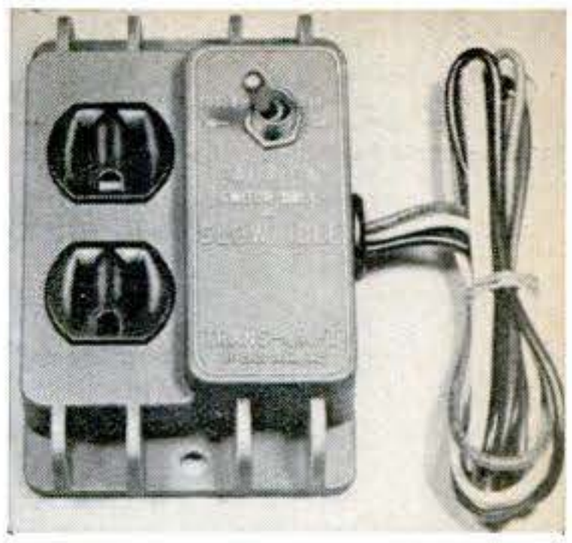
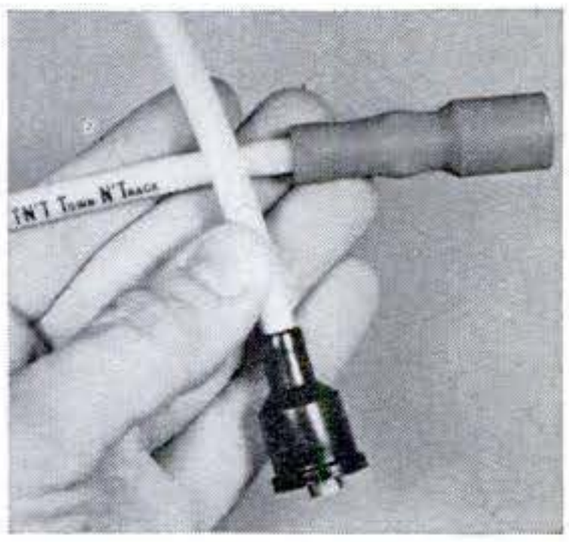
What's New
FOR YOUR CAR







High-voltage cable

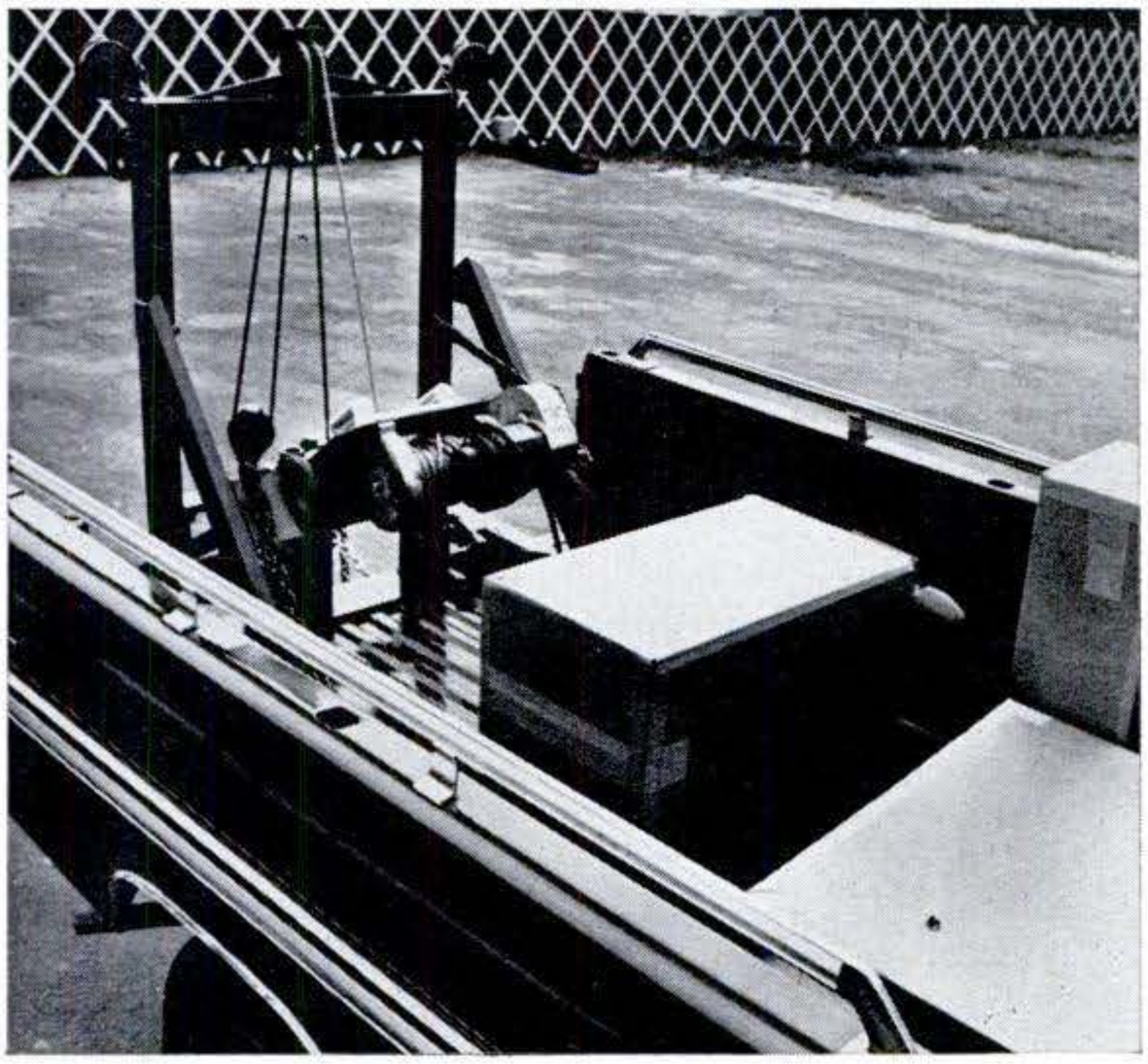
A nonmetallic cable to deliver peak voltage at temperatures to 450 degrees—that's Belden's Town 'n Track cable for high-performance vehicles. It's good for town use, too, since it suppresses ignition radiation for static-free radio and tape-deck operation.

Leveling block

Carry a Bloc Jac with you and you can level your station wagon or rec vehicle with ease. Adjust for the extra height you need—from three to six inches—and roll your wheel up the ramp. Price: $24.95 from Jen-Tec, Box 201, Bellevue, Wash. 98009.

Power supplier

Power tools drawing up to 3,000 watts can be run off your car's alternator with PAT (Power Accessory Tap). It gives you 110 volts wherever you want it. Use it, too, to charge a 12-volt battery through up to 100 feet of cord. $24.12 from Trans-Dapt, Box 4157, Compton, Calif. 90224.



Tow converter

Turn your pickup into a tow truck? Right. Au-Tow-Lift gives you up to 8,000 pounds of pull/lift capacity while leaving room for storage. The rig comes complete with tow chains, lights, and mounting components. United Design & Engineering, 1601 So. Main St., Darlington, S.C. 29532.

Load leveler

Air shock absorbers adjust for heavy loads with this device. You just dial the pressure you want for a level ride. The Scovill load-leveling system turns itself off when the dialed pressure is reached. It's about $40. Scovill Mfg. Co., 99 Mill St., Waterbury, Conn. 06720.

Wireless starter

On your breakfast table is a small pocket-type radio transmitter. You press the button. Outside, your car starts, warming up (or cooling off). Credit the RemoStart—a radio remote starting system. Price (installed): $249. E. J. Kneip & Assoc., 5203 Schaeffer Rd., Dearborn, Mich.

Pressure tester

Tire pressure or cylinder compression—this gauge measures both. A vent (you push down the rubber sleeve) allows repeated compression readings without removing the seven-inch device from the spark-plug hole. It's by Pneumatic Components, Ltd., Eyre St., Sheffield, England.

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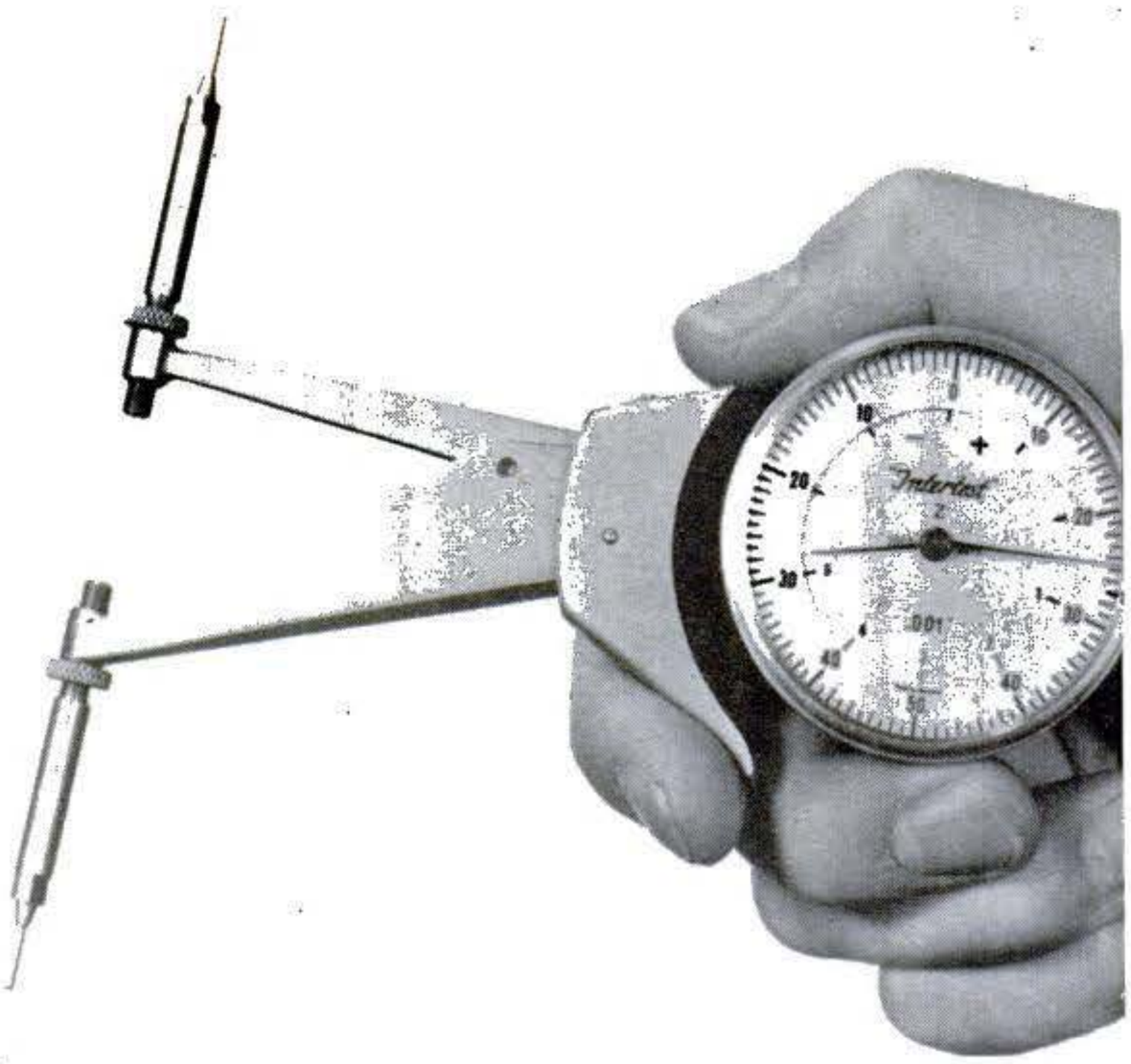
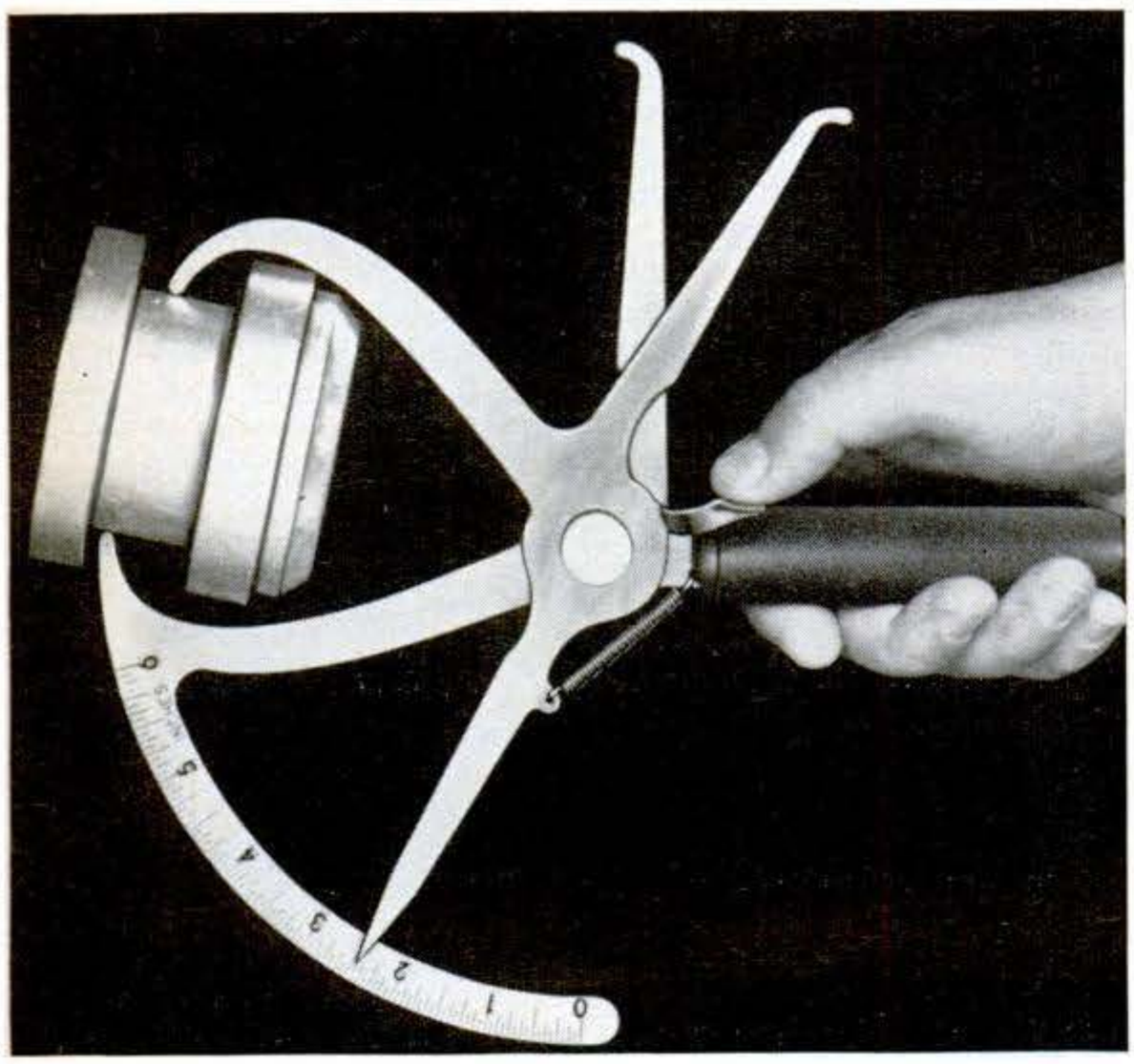
What's New IN TOOLS

Easy I.D.'s

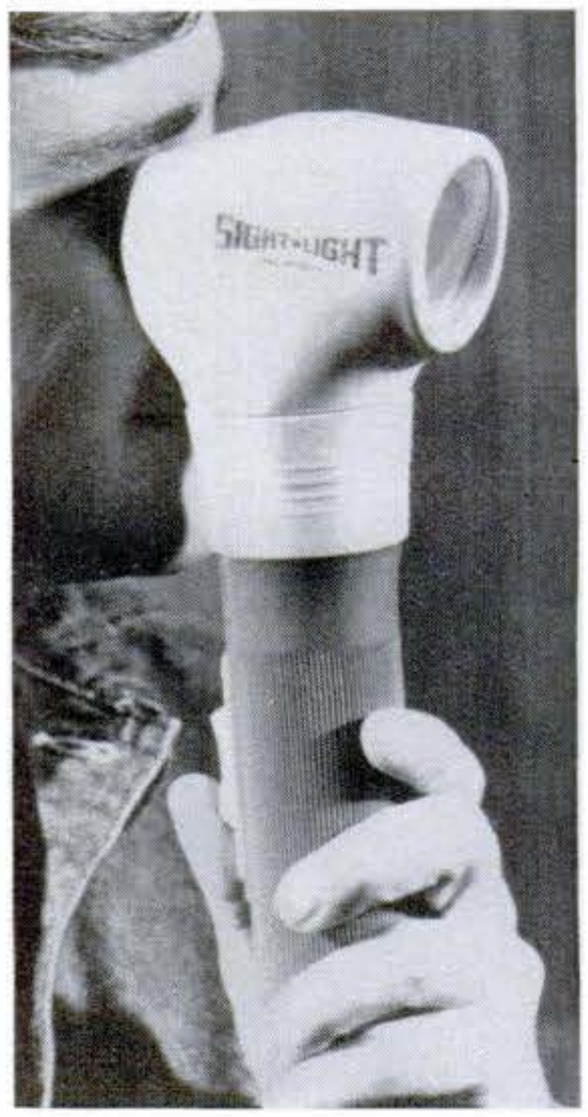
Measure I.D.'s in the 4"-8" range with an accuracy of 0.001"? It's easy with the new Intertest Z; it even measures grooves and offsets as deep as 0.4". You set it with a micrometer, ring gauge, or known component. The Dyer Co., Box 449, Lancaster, Pa. 17604.





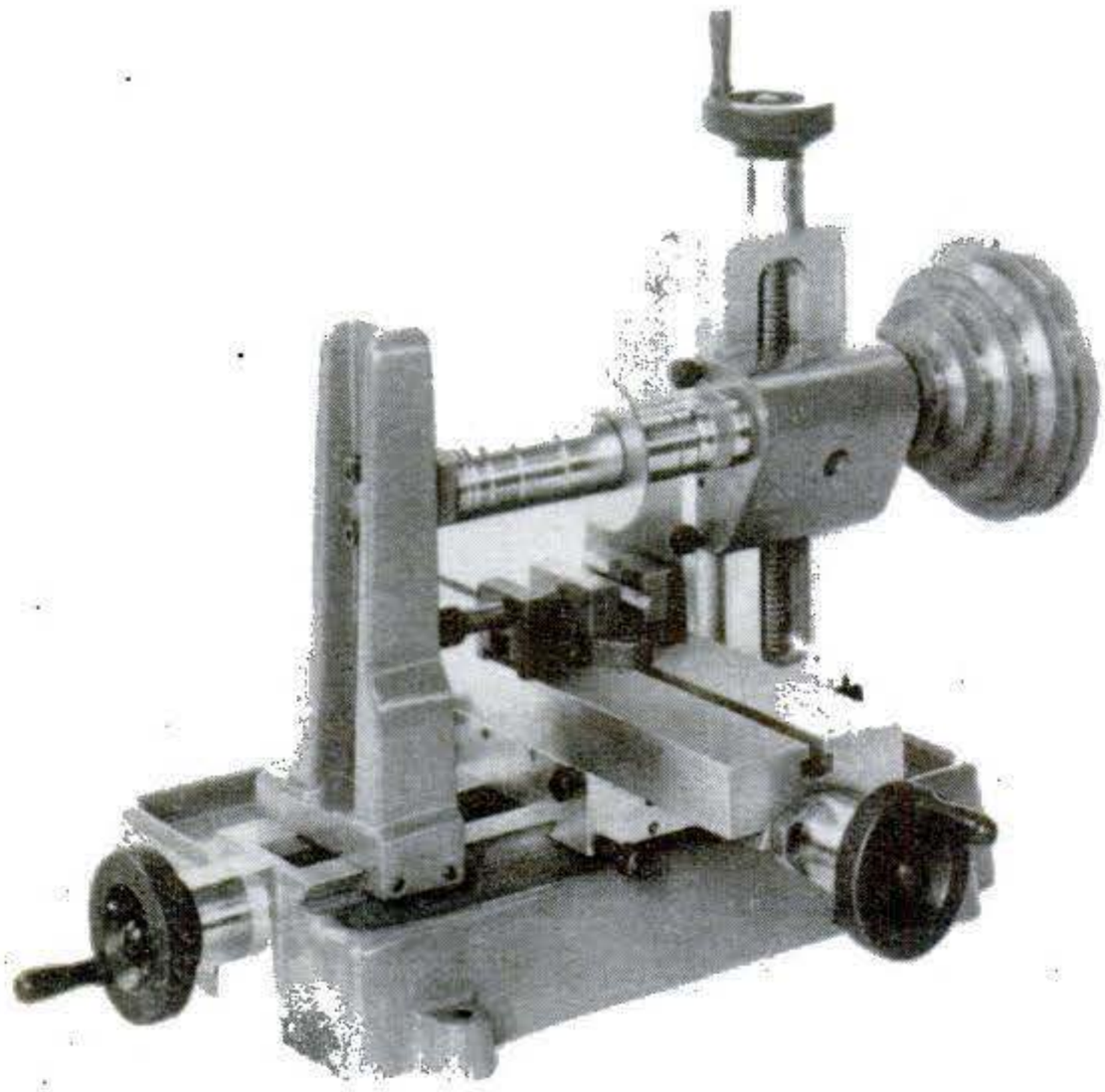
For ins and outs

One tool takes the place of three usually needed to measure both inside and outside diameters. The Accro caliper covers the range from 0"-6", reads directly in ⅛" units. It's $32.50 from Indicating Caliper Co., Box 51, Oak Park, Ill. 60301.



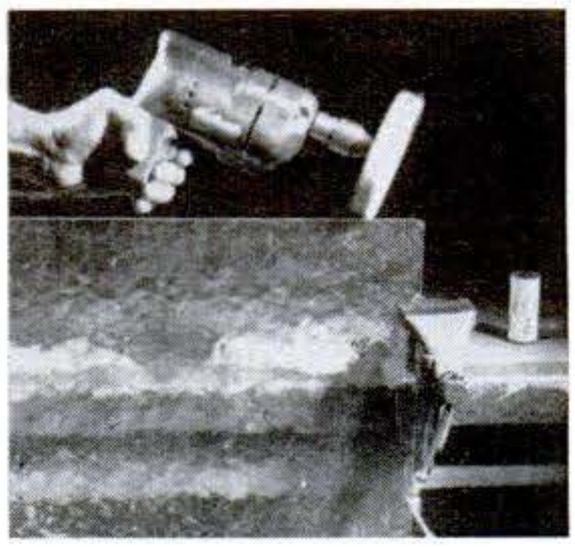
See-through flashlight

It's a lot like that instrument your doctor uses to look in your ears. You use it to look down pipes, or into other tight spots. Sight-Light is $4.95 ($5.95 with 2x or 5x magnifier, $6.95 with both) from Ward International, Box 3628, Granada Hills, Calif. 91344.



Little miller for home machinists

Want a nice little milling machine for your shop? You can get the one above any of four ways. Buy it complete for $399.50, as a semi-finished casting kit for $199.50, as a rough casting kit for $49.50, or—if you're a real hot-shot machinist—just buy the $2.50 blueprints. Microm Co., Santa Ana, Calif. 92707, is your source. Don't like any of the four choices above? Wait a while. Microm plans to offer a complete parts kit in the near future.



Plastic polisher

The easy way to polish Plexiglas? With the new Dico buffing kit. For about $2.50 you get a cloth buffing wheel and a stick of buffing compound, plus instructions. The wheel is designed to work at electric drill speeds—you need no other special tools.

Odd couple

This two-man team of tools comes in one package for $4.34. The item on the right dials any setting you want, to sharpen knives, scissors, axes, and more. Next to it is a Cap Snaffler (it removes jug, bottle, and jar lids). Scan-Am Enterprises, 23404 Hartland, Canoga Park, Calif. 91304.

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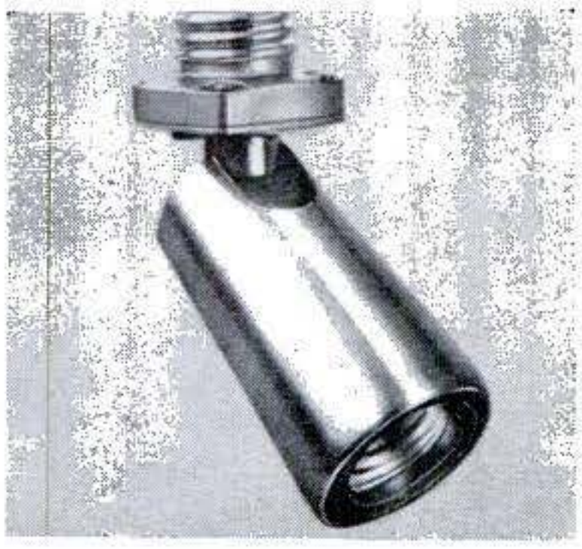
What's New IN HOME IMPROVEMENT

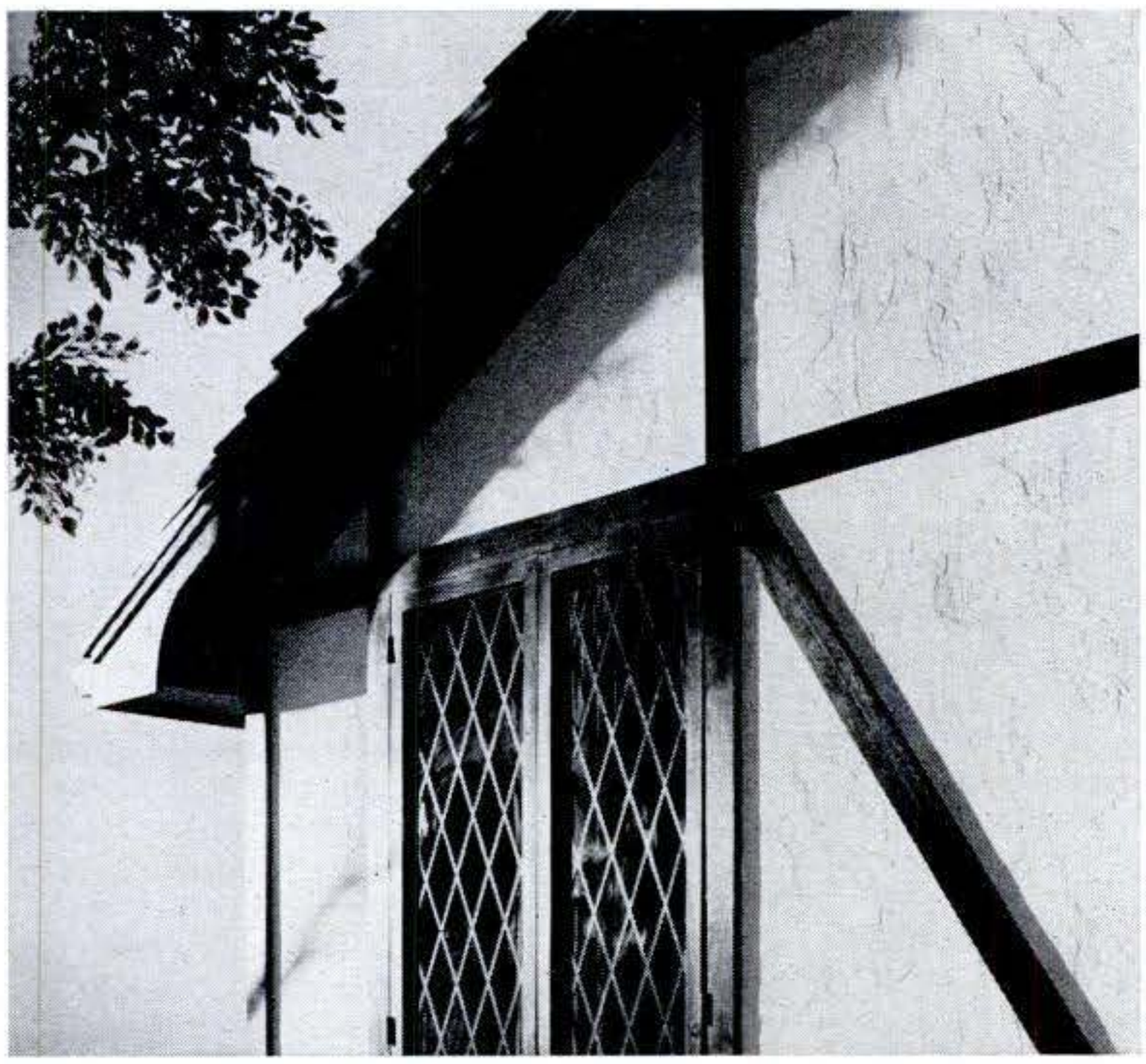
Cool, clear water

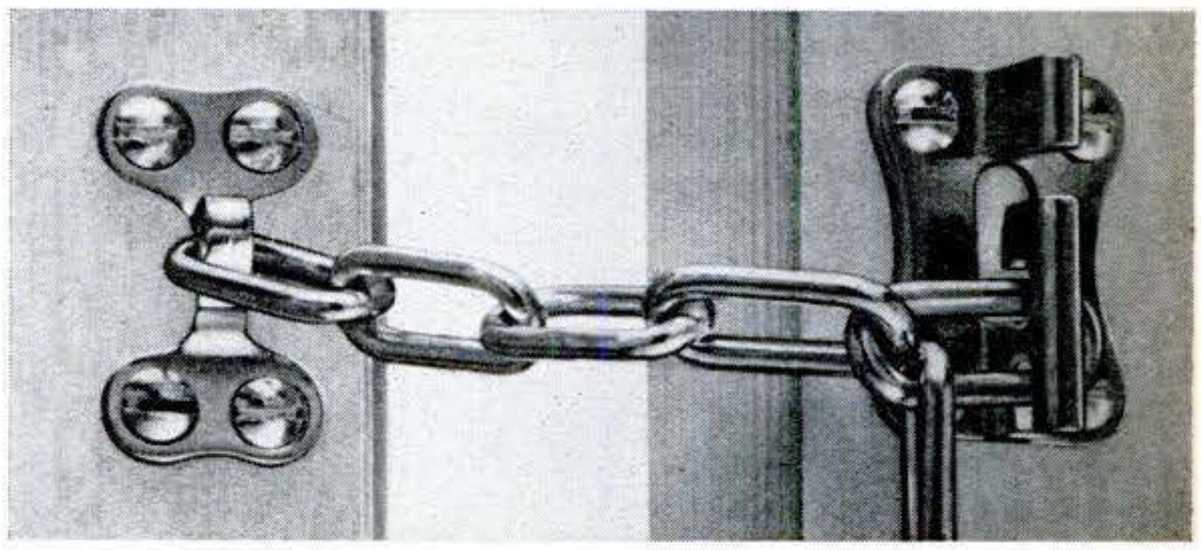
If your water tastes lousy and your sink has a hand sprayer, you're in luck. Install the Aqua-Tap filter under your sink (no need to cut pipes), replace the sprayer with a special faucet (supplied with filter kit) and have a drink.



Bright idea

Now it's an ordinary light socket—next it's a swiveling light fixture. The new Swivelier Screw-In light does the converting—you just screw it in like a light bulb. Single- and double-socket models are $3.75 and $7.25 at hardware, lighting, and department stores.



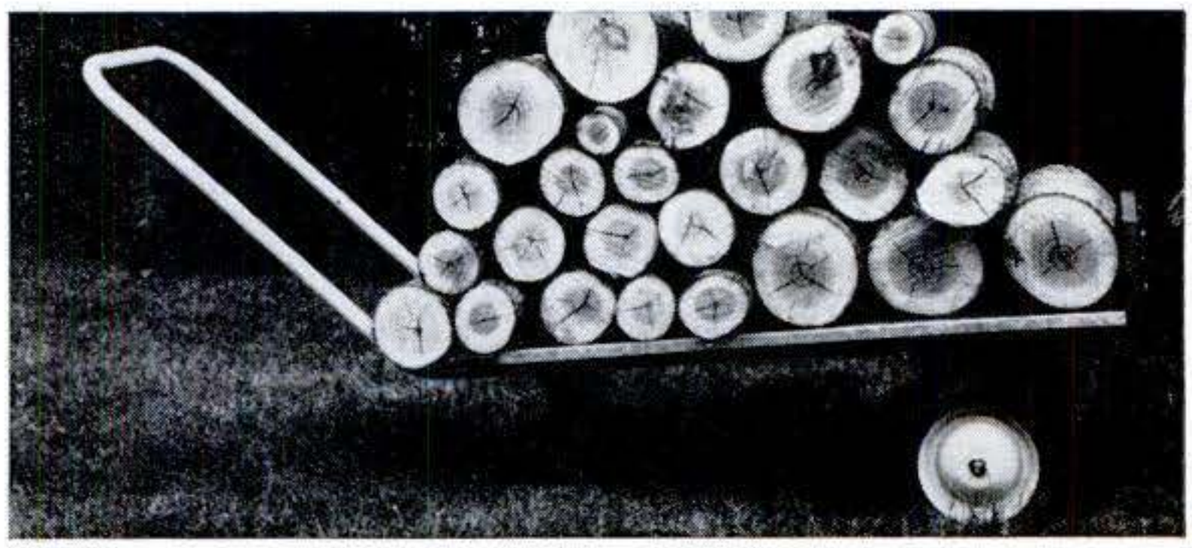


Stucco siding

Skip-trowel stucco? No, it's a new form of exterior siding from Masonite. Stuccato comes in 4-by-8 and 4-by-9 panels, prefinished in white—a natural for Tudor-style homes. Shiplap edges let you run a single row of nails speedily at joints.

Adjustable lock

Adjustability is the unique feature of the Select-A-Link door fastener. Use any of its three hardened-steel links to allow just the opening you want for viewing or ventilation. It's secure, because the locking link must be vertical to open. National Mfg., Box 577, Sterling, Ill. 61081.



Load mover

Haul logs in the suburbs, groceries in the city, outboards at the marina, bricks at the building site. Any way you use it, Mini-Kart lets you move up to 350 pounds the easy way. It's $17.95 from Leisure Labor Savers, 208 S. 3rd St., Philadelphia, Pa. 19016

Kit floor

Now here's a real luxury floor—polished, prefinished walnut, accented with brass plugs at the ends of the random-width planks. It comes in packages of 20 square feet, complete with screws and instructions. Wood-Mosaic Corp., Box 21159, Louisville, Ky. 40221.

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What's New
IN BOATING

Sea stove

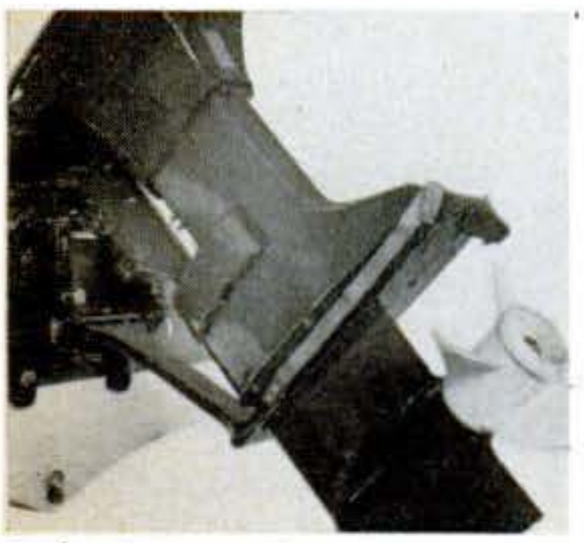
Soup or coffee won't spill in rough seas with the Sea Swing stove—it's gimbaled to stay level, and a deep receptacle hangs on to pots. The five-pound aluminum stove takes up only a cubic foot on your galley bulkhead. Cost? $23. Maker is Bremer Mfg., Box 548, Elkhart Lake, Wis. 53020.

Lightweight kayak

Strands of carbon fiber brace the Scorpion slalom kayak to make it both stiffer and lighter. Designed for racing, she's a foot high, two feet wide, 13 feet long, and weighs a mere 20 pounds. Builder: Streamlyte Moldings, Churchill Ind. Estate, Lancing, Sussex, England.

Plastic prop

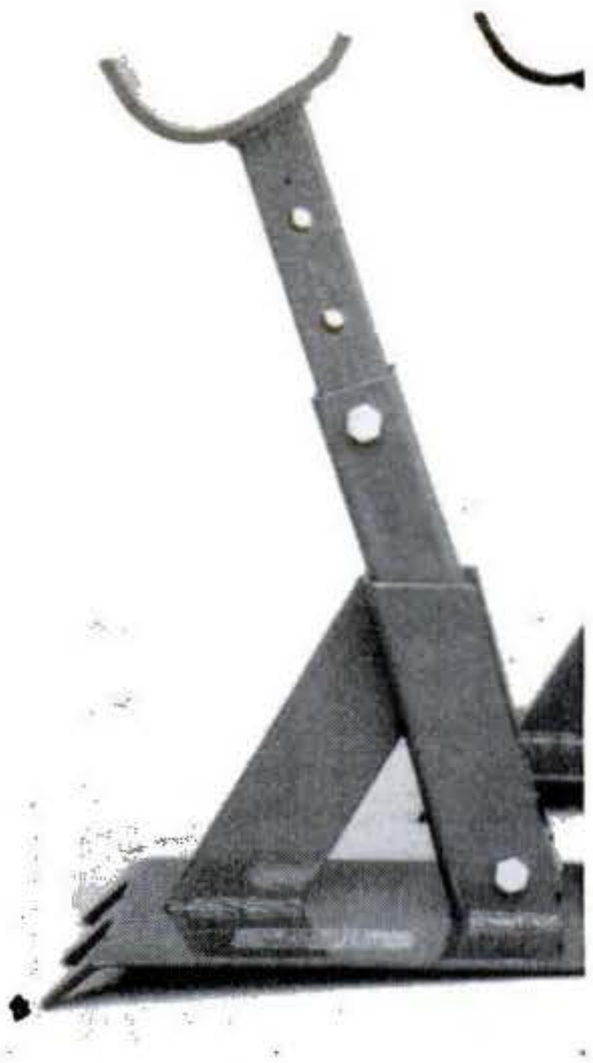
Troll a lot in shallow water? Now you can get a plastic prop for OMC six-hp outboards that'll resist damage from rocks and stumps. Scrapes and nicks on the leading edge can be dulled with a knife. Price: $6. From OMC Parts and Accessories, Galesburg, Ill. 61401.



Outboard clamp

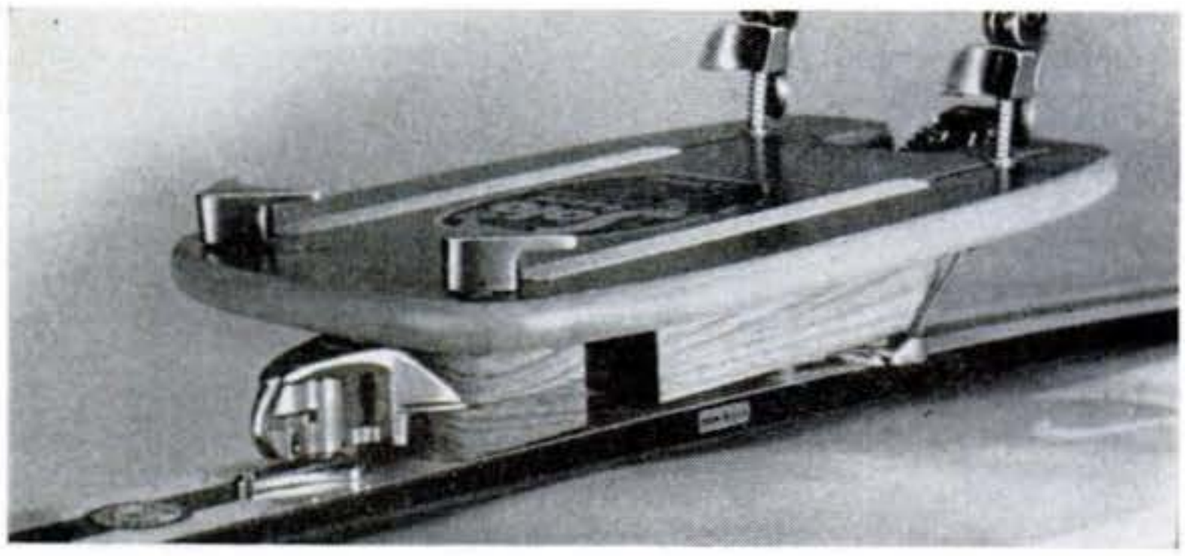
Here's welcome news if you've ever damaged a prop on the pavement while towing—the Ell Vee two-way clamp. The aluminum device keeps your outboard from bouncing or dropping. Price: $24.95 plus shipping. Mountain Marine Safety Products, Box 67, Dupont, Colo. 80024.

What's New
IN OUTDOOR RECREATION



Trailer jack

Mini-Jack's the answer to a trailer's flat tires. Set it in front of the axle with the U-bracket arm resting on the axle. Pull the trailer ahead and—presto!—it's in the air. The jack supports 3,000 pounds, sells for $12.95 ($19.95 for two) plus shipping. Leisure Labor Savers, 208 S. 3rd St., Phila., Pa. 19016.



Two-feet ski

Ever go skiing with only one ski? It's tricky. But you can give it a try with a Solo Board. The pedestal board adapts easily to your conventional release bindings. It's $24.95 from Alpine International, Box 8501, White Bear Lake, Minn. 55110.

Portable grill

Kangaroo Kitchen does everything but set the table. Powered by standard propane fuel, it broils, bakes, barbecues, smokes, steams, toasts, and fries. It'll double as a dishwasher, too—fill it with water. It weighs 12 pounds and is from J. C. Penney.

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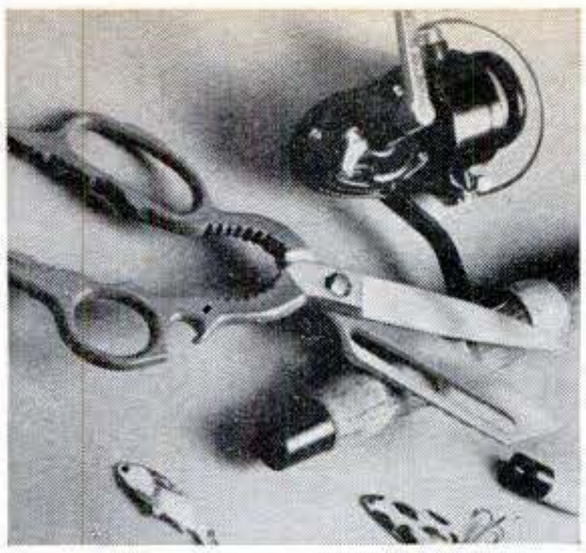
What's New IN ELECTRONICS

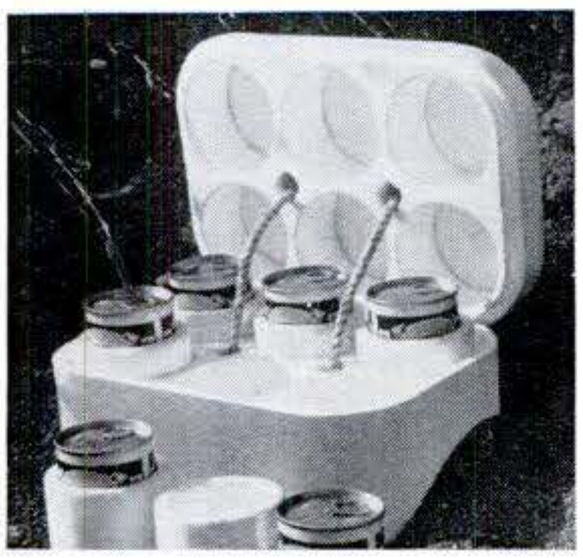


Fisherman's shears

There's less mess for fishermen with these new shears. They feature a serrated blade for cutting fins, tails, and heads; the back of one blade is a scaler; one handle is a bottle opener; and the handles double as pliers. Price: $6.50. J. Wiss & Sons, 400 W. Market St., Newark, N.J. 07107.

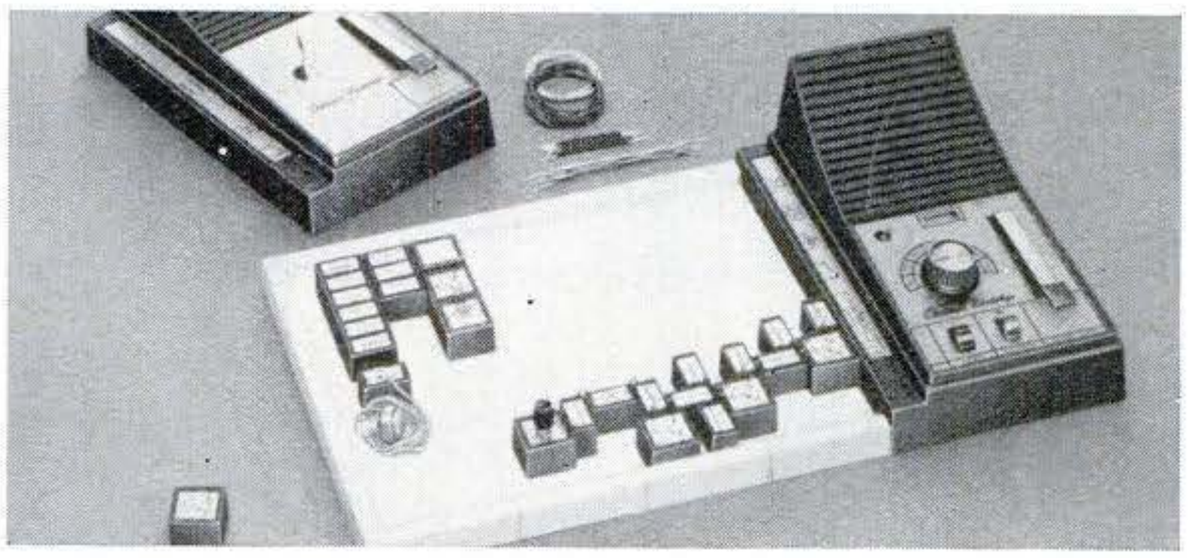
Wall stereo

No room for stereo components? Here's a compact system that's designed to go into a wall. Nutone's Musicom compact includes AM/FM tuner and amplifier. The fold-away record changer is an option. NuTone, Madison and Red Bank Rds., Cincinnati, Ohio 45227.



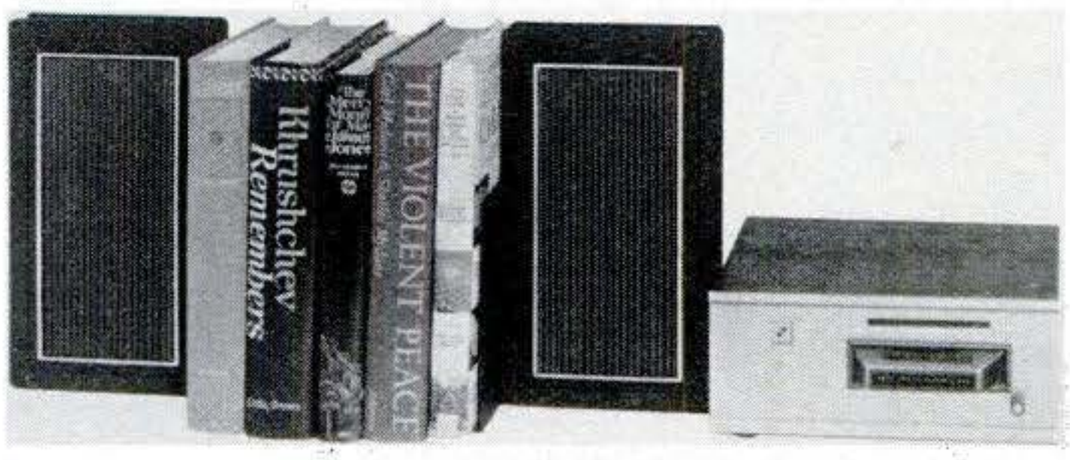
Hot 'n' cold holder

Hot or cold, beverages will stay that way for 12 hours in the double-insulated Desert Pak container. Six sleeves hold individual cans or bottles, to keep them insulated outside the box. Weight: ¾ pound. Price: $4.95 from Triance Enterprises, Box 283, Dayton, Ohio 45420.



Electronic shop

All the elements of basic circuitry—including transistors, capacitors, and resistors—are here in this electronics kit for kids. And there's nothing to solder—components snap in. The 36-experiment kit is $29.95. Smaller kits are $19.95 and $24.95. Heath, Benton Harbor, Mich. 49022.



Bookend speakers

These speakers double as bookends. Black, trimmed with chrome and walnut-toned vinyl, they're rated at 18 watts, deliver a range of sound from 70 Hz to 20 kHz. Retail price: $29.95 a pair. They're made by Magitran, 311 E. Park St., Moonachie, N.J. 07074.

Quick toaster

Miss your favorite breakfast snack on your last camping trip? Next time fix toast or muffins two at a time with Camp-A-Toaster. It works on any standard-diameter burner of an LP or gasoline stove. It's $4.95. From Waukegan Outdoor Products, 4419 Grand Ave., Gurnee, Ill. 60031.

High-energy video

Big boom coming up in video players? 3M thinks so, and is bringing out this new line of video cassettes. Size and shape of an average book, they'll come in 30- and 60-minute versions. The U-Matic cassettes will offer "high-energy" tape for better fidelity.

Mobile CB unit with dual-receive capability

Call coming in on one CB channel while you're listening to a different one? The Messenger 323-M puts it right through. A signal light lights up, and the call is automatically put on the speaker. Don't want to be interrupted? Switch from automatic mode to alert, and there's only the light—to tell you a call is waiting. The dual-receive capability lets you use any of the 23 channels while monitoring another. Price? $289.95. E. F. Johnson Co., Waseca, Minn. 56093.

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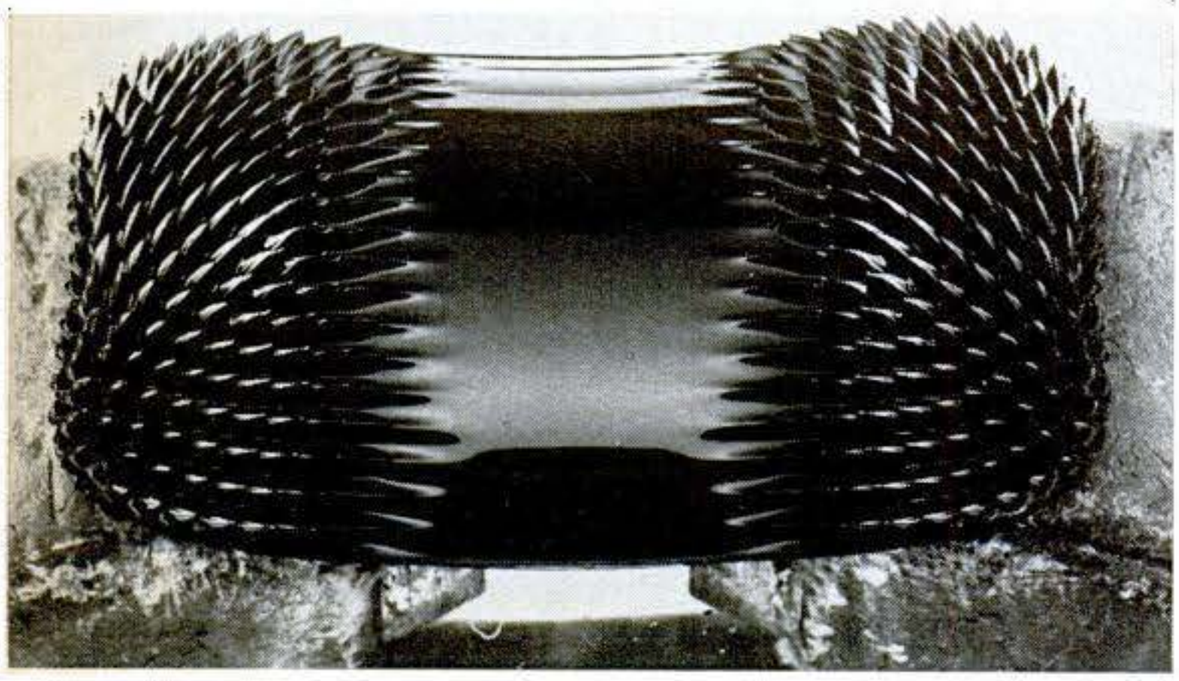
A new technology is evolving as magnetic ferrofluids are applied to fields ranging from pollution control and frictionless bearings to medicine

The Curious World of MAGNETIC

HOWARD WISE GALLERY

Jumping stalactites: This participation sculpture by artist Takis employs a pool of magnetic ferrofluid and a large electromagnet. A rheostat enables you to vary amount of liquid attracted to the magnet.



Ferrofluid sample exhibits this strange burr-like appearance, yet remains in liquid state. It's on a watch glass over a magnet.

In vertical magnetic field, "strong" ferrofluid develops long spikes. Some fluid surface properties still puzzle scientists.

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LIQUIDS

By JOHN R. FREE
ILLUSTRATIONS BY RAY PIOCH

An electromagnet hummed beneath a cup of coffee-colored liquid. As I watched, something startling happened. A nylon ball suddenly popped to the fluid's dark-brown surface.

Then current to the magnet was slowly increased. Now a glass pellet bobbed to the surface. And finally, another nonmagnetic object—a heavy bronze bolt—was mysteriously expelled from the fluid.

Scene: Avco Corp.'s ferrohydrodynamics laboratories near Lowell, Mass., where pioneering work on a fascinating space-age development, magnetic ferrofluids, began nearly a decade ago. At the lab I discovered you can:

- Drop a magnet in a container of ferrofluid and it will hover in the middle of the vessel—levitating itself against gravity.
- Place even dense nonmagnetic metals like lead or uranium in these amazing liquids and force them to the surface with a small magnet.
- Snake a column of fluid up the inside of a beaker using a magnet.

What good are these tricks? After years as a laboratory curiosity, ferrofluids are beginning to emerge as a significant new technology. "The dramatic advances have occurred only recently," says Dr. Ronald E. Rosensweig, whose Ferrofluidics Corp. in nearby Burlington is turning out ferrofluid-based hardware. At Avco, Rosensweig and others probed the mysteries of ferrofluids before he founded Ferrofluidics.

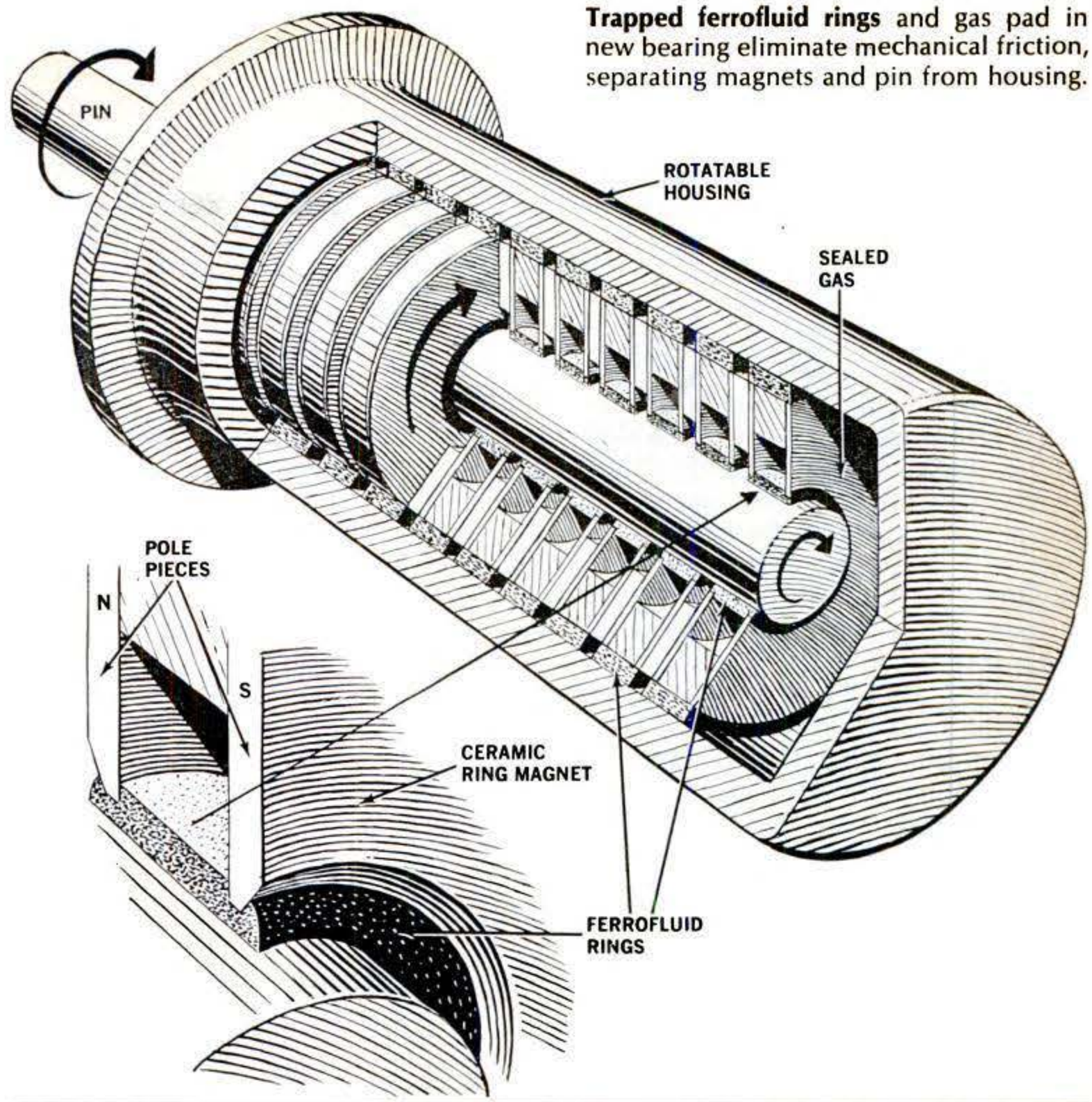
Brewing rocket fuel. The new magnetic liquids sprang from a NASA problem: How do you keep weightless rocket fuel from bubbling around in half-empty fuel tanks? In the early '60s, the space agency's S. Stephen Papell developed a means of magnetizing hydrocarbon fuels so they could be magnetically pulled to fuel pumps. His propellant-control method wasn't adopted, but Papell's technique for preparing the first ferrofluids is the one used today:

Magnetite, or another iron-oxide powder, is crushed in a ball-mill grinder with a carrier liquid—water, kerosene, fluorocarbons, silicone—and a stabilizing agent such as oleic acid. The stabilizer forms a molecule-thin elastic cushion around each particle, preventing them from linking together. Also, the stabilizer's string-like, long-chain molecules mingle with carrier molecules; a particle moving in a magnetic field "pulls" carrier liquid along with it.

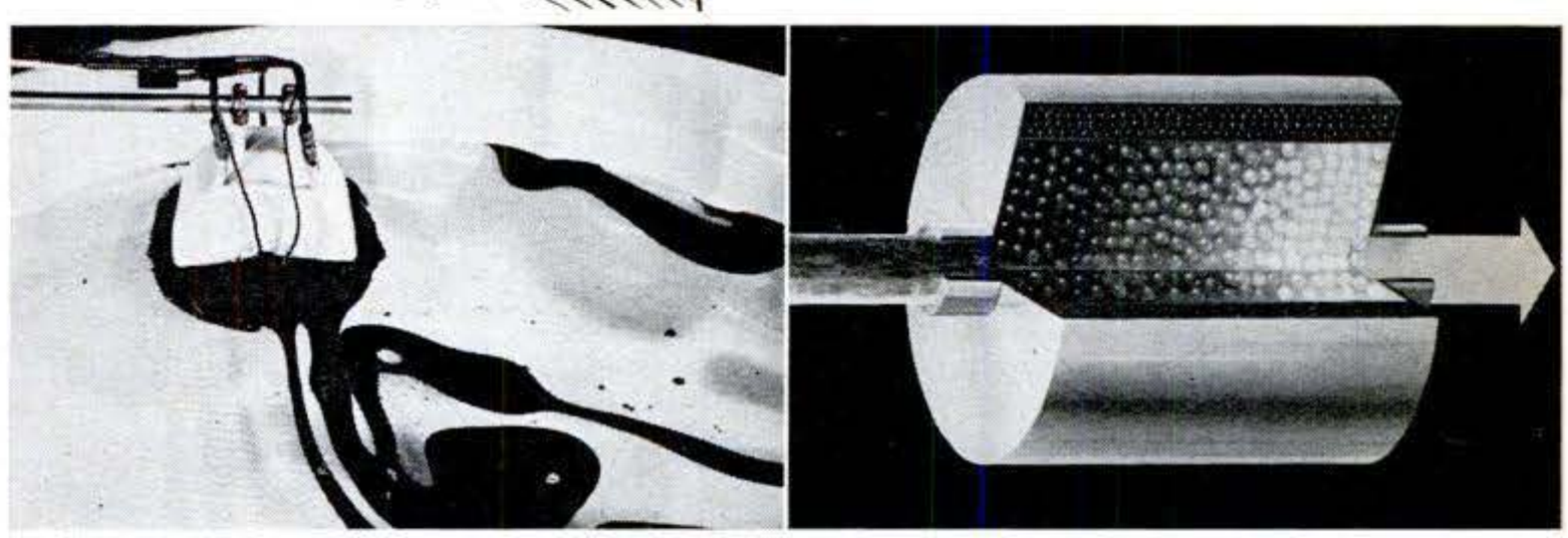
Tumbling may continue several weeks, gradually pulverizing particles to microscopic 100-Angstrom diameters. These minute, virus-size particles are separated and kept in suspension by random thermal agitation of carrier-fluid molecules. Finally, centrifuging the ferrofluid to 17,000 g separates unground particles.

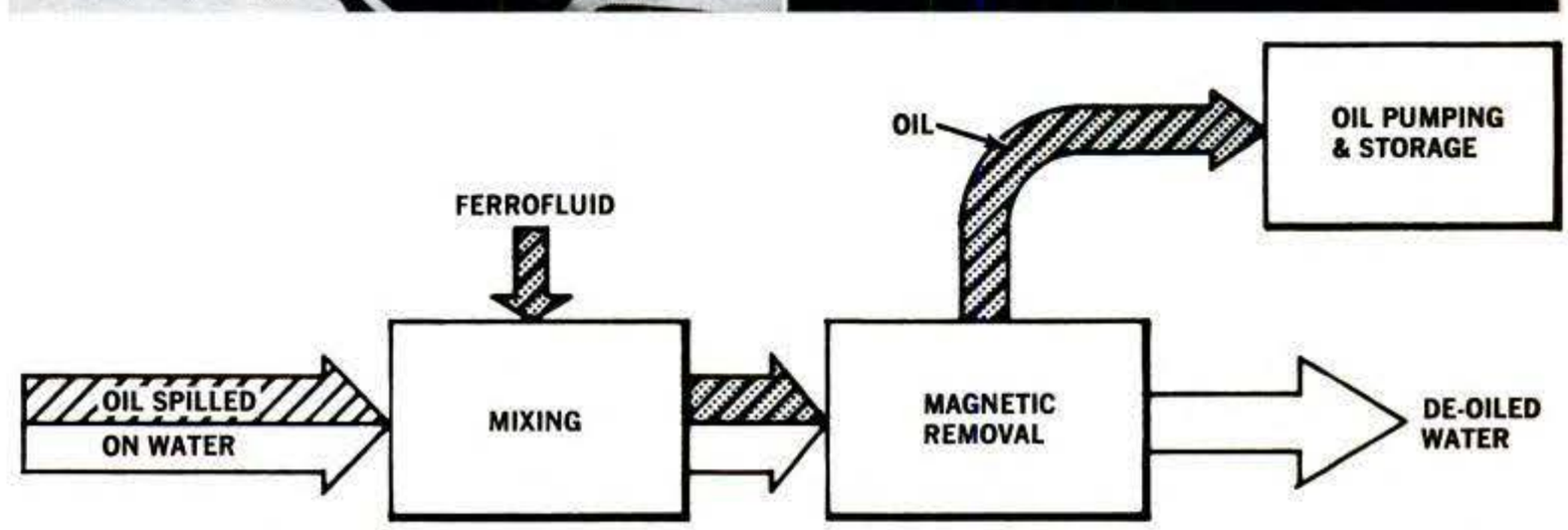
A pressure boost. One practical—but limited—application for selectively forcing submerged material from ferrofluids: the densitometer. As you crank more current into an electro-

Continued



Trapped ferrofluid rings and gas pad in new bearing eliminate mechanical friction, separating magnets and pin from housing.





Oil-spill recovery system diagramed uses ferrofluid that mixes with oil but not water. Photo, left, shows ferrofluid/oil mixture drawn to lab magnet. Pellet bed encased by electromagnet (drawing, right) removes ferrofluid/oil from water-base lubricant.

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magnet (such as Avco's prototype instrument demonstrated), ferrofluid pressure soars. The particles—quadrillions per cubic centimeter—tend to expel anything separating them. This increased pressure alters the buoyancy relationship of objects within the fluid. With the electromagnet's current known, a material's specific gravity can be read on a meter.

How about large-scale applications for this variable specific gravity? One possibility is using ferrofluids to separate various metals from shredded automobiles and other scrap. Similarly, ores of various densities as well as mineral grains could be selectively sunk.

Spinning on fluid. Rotary seals and bearings may become one of the most significant ferrofluid applications. The seals, introduced recently by Ferrofluidics, are used where rotary shaft motion must be transmitted through a vacuum or pressure chamber. Conventional seals rely on mechanical contact that eventually wears and leaks. In ferrofluid seals, the shaft housing contains a series of ring magnets that hold a belt of the fluid. This belt is a vacuum-tight seal, eliminating friction between solid materials. Applications so far: primarily industrial vacuum equipment; they may also be used for industrial refrigerator compressors.

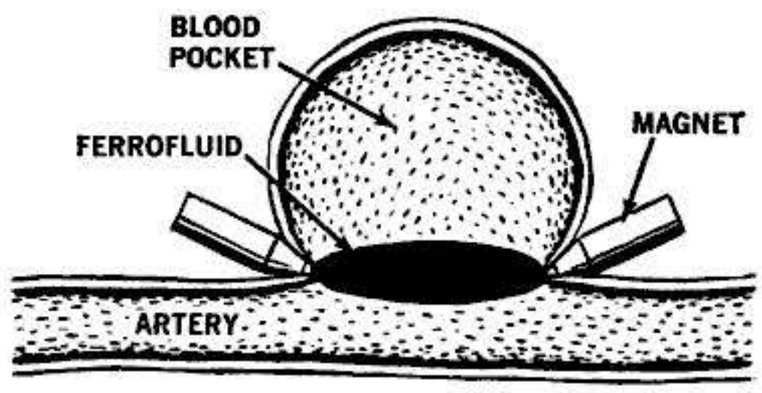
Ferrofluid seals are also under development for super-flywheel projects ["Super Flywheel to Power Zero-Emission Car," PS, Aug. '70], where the energy of high-speed, high-mass flywheels spinning in a vacuum is transformed into motion.

The firm's just-patented bearing should find even wider applications. Like the seal, the bearing uses magnetically trapped ferrofluid rings. A pad of gas trapped by fluid rings (see drawing) generates a pneumatic force when a load is applied to the rotor pin. The ferrofluid rings prevent pin contact with the housing wall, so the rotor is suspended free from mechanical contact. This means zero starting torque, no wear or mechanical friction, silent operation, and less-strict mechanical tolerances. Unlike conventional air bearings, no bulky compressors, controls, and power supplies are needed.

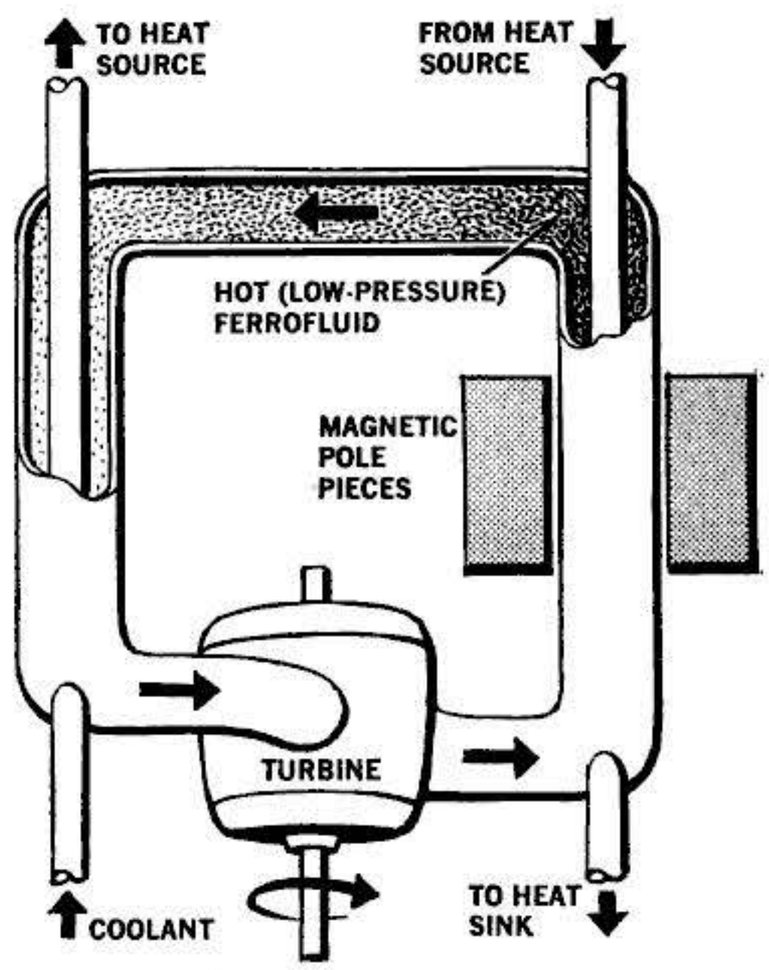
You're likely to see the bearing in a rumble-free, hi-fi turntable (Ferrofluidics is licensing a phonograph manufacturer). The Navy and others are looking at the bearings for silent fans and blowers; they're also suitable for textile spindles, instruments, and computer-disk readers.

One problem that had to be solved was developing magnetic liquids with a very low volatility or tendency to evaporate. "The fluids must hang around for years in these applications," says Rosensweig. "Having done this," he adds, "the hardware has found quite a niche for itself." Both Avco and Ferrofluidics produce a variety of ferrofluids, available in a range of "strengths," depending on their density and saturation magnetization. (An inexpensive ferrofluid "doodler" is available from Edmund Scientific Co.)

Magnetic pollution control. Now that polluting rivers and lakes with oily industrial waste is no longer regarded as permissible, manufacturers are looking for methods of preventing it. Avco came up with a process for removing oil from oil-contaminated industrial water as well as ship bilge and ballast waters.



Medical use of ferrofluid being studied involves magnetically positioning fluid at arterial aneurysm until scar tissue forms.



Converting heat directly to mechanical energy by heating and magnetizing ferrofluid simultaneously: This creates a pressure difference across magnet (and flow)—the field boosts pressure and heat demagnetizes.

Their Magnecol ferrofluid is tailored to be miscible with the oil portion of an industrial-waste emulsion—but not with the water. When the mixed emulsion is passed through a simple separator (see drawing) the oil-ferrofluid is collected, leaving the water free of visible oil.

The magnetic liquid may also be used to clean up accidental oil spills. Magnecol would be sprayed on the oil in a ratio of one part ferrofluid to five parts oil. Avco has developed a 40-pound prototype "magnetic broom" that is pushed over the oil slick, magnetically pulling oil into a gap where it's collected. Tests show even one-millimeter-thin slicks can be collected. Rough cost: under one dollar per gallon of oil collected.

Magnetizing your body. The medical profession is using ferrofluids too:

- At a children's hospital in Cincinnati, fluid was magnetically positioned beneath the skin near cancerous tissue. Selectively absorbed laser energy then destroyed diseased tissue.
- In Boston City Hospital, work has gone on using ferrofluids to seal arterial aneurysms—weaknesses in the wall of an artery that lead to stroke (see drawing).
- Groups at Avco and Stanford University use the magnetic liquids to detect flow and circulation of blood. Artificial hearts employing ferrofluids might do away with the need for electric motors and hydraulic pumps.
- Positioning ferrofluids—instead of patients—may make X rays easier.

Nonmechanical pumps. Early ferrofluid research involved turning heat into work for space-satellite power supplies. E. L. Resler proposed a *magnetocaloric cycle* using the magnetic fluids, and he and Rosensweig developed the concept.

"Visualize a horseshoe magnet and a chunk of iron," Rosensweig explained. "You let the iron be attracted toward the pole pieces, but while it's moving you heat it to its Curie point so it's nonmagnetic. Instead of being retarded by the magnetic field, it'll fly by it."

The analog is an experimental system developed at Avco to demonstrate the principle. Cold ferrofluid within a pipe (see diagram) is attracted to a magnet where its pressure rises. Heating the fluid within the field reduces its magnetic strength, so it leaves the field with more pressure. The difference in pressure generates a flow that can be used to turn a turbine or generator.

So far, the poor efficiency of such an arrangement has confined it to the laboratory. Key to a working system is the regeneration portion of the cycle—cooling the heated ferrofluid. This awaits development of ferrofluids, such as liquid metals, with high thermal conductivity. Scientists haven't figured out how to prevent magnetic particles from linking together in a liquid metal (like eutectic sodium potassium), which would change its viscosity.

But as Rosensweig points out, present-day ferrofluids are crude compared to what should ultimately be attainable. PS

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Starting Here: 11-Page Annual Boating Section

Sea Knife: A Wild Boat for Wild Water

Radical new hull for high speed on big water aims to slice through where others go up and down

By **JIM ROE** / *PS Boating Editor*
PHOTOS BY OZZIE SWEET

It's like no boat you have ever seen. The revolutionary new Sea Knife, looking like a cross between an aircraft carrier and a delta-shaped dart, has been cutting through choppy eastern waters in recent months in a bid to outmode existing high-speed rough-water hulls. She just might do it.

In trials she is reported to have cleanly parted waves of four to five feet with lengths of 20 to 40 feet, at speeds near 50 mph—with no pounding. Where the best of conventional hulls have to drop speed to keep control, the Sea Knife zips.

Peter Payne—the Sea Knife's inventor, manufacturer, and eloquent exponent—says his boat is developed from a blend of hydrofoil, aircraft, and planing-hull technologies. He describes its bizarre configuration as a

[Continued on page 132]

Dart-shaped hull with flat bottom, scooped bow, and extreme flare gives boat a new edge at high speeds. That's a "bustle" added to transom over the lower unit.

Without hatch covers, 22-ft. aluminum test model in foreground shows space limitations of design.

Sea Knife planes on small area of flat bottom at speed in calm water. But in rough seas, bow cuts through waves rather than riding over them at slower pace.

Boats with a Purpose for '72

FAMILY FLIVVERS

Colorful—and her name's Gypsy. With fore and aft cockpits, the 15-ft. MFG is a whole-family boat for skiing, running, fishing. That's the new Merc 650 on the transom.

Invitation to a day's cruise: Wellcraft 18 has a cuddy cabin and is trailerable. The tri-hull is designed by Dick Cole to plane quickly, use less gas. Motor's a Johnson.

Runabout red and rally striped, Chrysler's new Charger 154 takes up to 85-hp outboard power. Options include a convertible top, and there's a glove compartment inside that name panel.

Sassy but spacious, the 18-ft. Golden Crown with Chrysler's stepped tri-hull and big 140-hp motor will go 40 mph. There's sleep-aboard space under deck. High transom keeps out backwash.

Just right for picnics, swims, everyday fun are the Kayot pontoon boats. This Evinrude-powered 16-footer is plenty large enough for four. Other Kayots—all shallow-draft—range to 28 ft.

Divers in a coral sea, their base is the G-W Invader powered by a 50-hp Merc. The 15-footer has a lounge seat forward of the center console, but the rest is all clear for scuba or skis.

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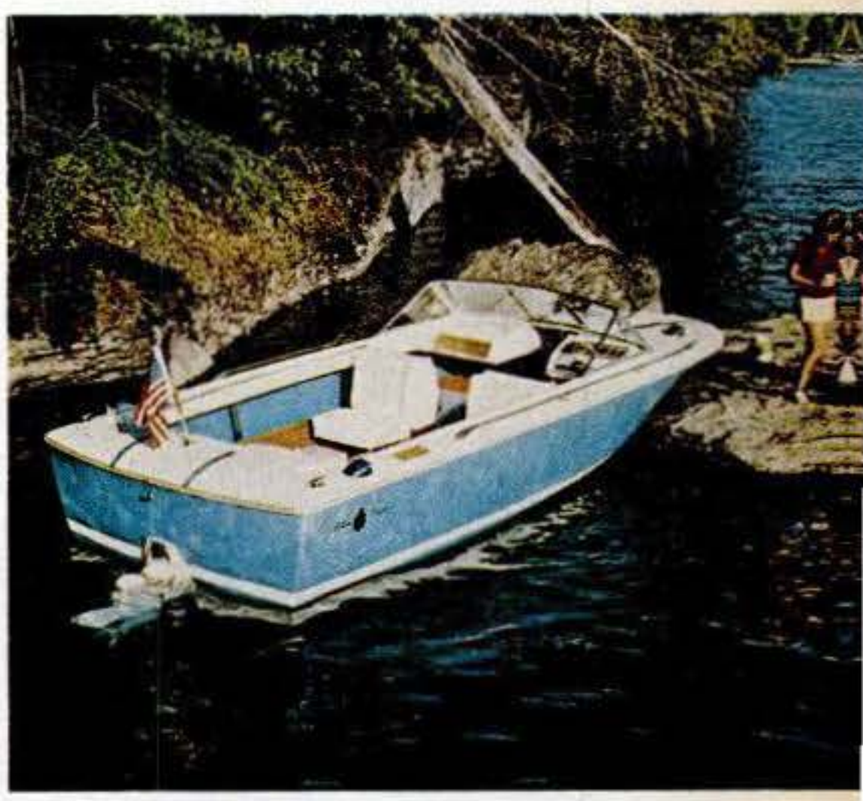
Special needs? The new boats do a better job of meeting them. And most in this PS gallery can take on all of your water activities

Name it, you'll have it on the new Sierra 21 by Glastron: laydown foam seats, aft sun pad, letdown swimmers' steps, ski locker, more. I/O power—even a 350-hp jet.

Now there's a family-style Boston Whaler—the Tashmoo, at left. Comfortable seats, and a little windshield for bow riders. Hull is Whaler quality; power, new Evinrude.

Starcraft's 18-ft. Holiday, built of aluminum, is available as stern drive (foreground) or outboard (background). Both models are rated to 140 horsepower, and are built to carry up to eight persons. Canvas top and side curtains are optional.



Some baby, they say, is Chris-Craft's smallest, the 17-ft. Lancer. The CC deep-V hull is fast, roomy, capable in rough water, and keeps you dry inside. Has sun-lounge seats; skis store under cockpit sole.

Penn Yan Sabre 18 lets you choose either stern drive or the famous Penn Yan tunnel design for inboard power. Lapstrake hull has Philippine-mahogany forward bulkheads and side trim.

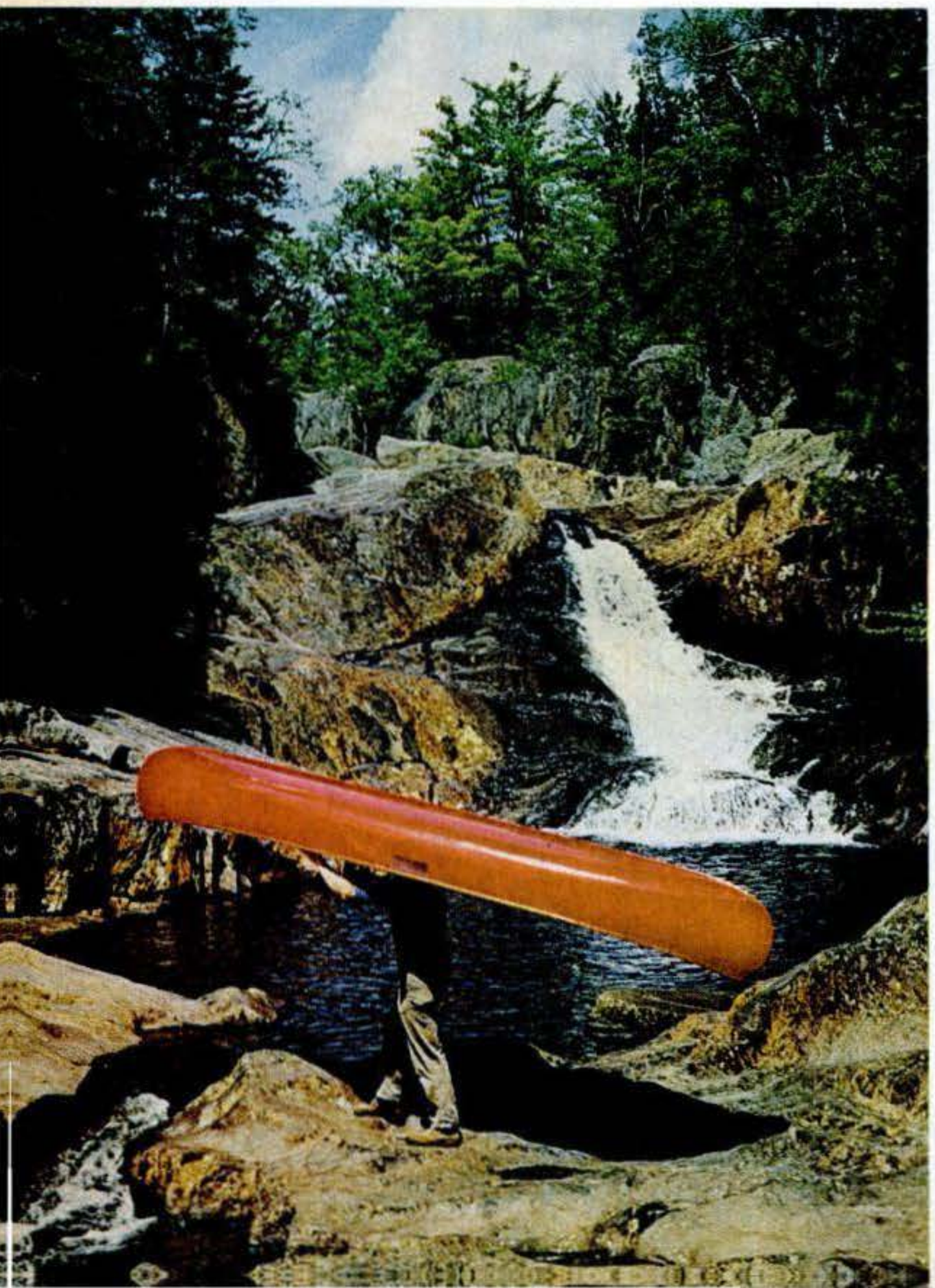
Kenner's Ski-Barge moves out with a Johnson 55. Center steering console has a companion seat, and families love the walk-around deck with plenty of space for action both fore and aft.

DRAG DEMONS

CV-16 is a Glastron-Carlson high-performance hull of superb quality and styling—metal-flake colors. Among features: padded dash and coaming, wrap-around windshield. Power is an Evinrude 100.

Hail Conqueror! Racy low silhouette, horizontal quarter-wings on Chrysler's 16-ft. shallow-V hull make top speeds with maker's new 130-hp stock outboard. Everything you see is standard.

Instant take-off and a soft, level ride are reported for Glastron's GT-160. Buckets swivel for ski-watch, and skis stash under that needle nose. BIA-rated for up to six people, 120 hp.



PADDLE POWER

Secret of Old Town's lightest canoe (left) is dacron covering. The 15-ft. Featherweight weighs only 46 pounds—perfect for portaging. Some surface smoothness is sacrificed; strength isn't.

Old Canada style canoe (high ends, broad waist) has birch-bark styling, but it's made of hand-formed aluminum. Foam lining, detachable sponsons make the 12-ft. Radisson hard to tip or sink.

Canoe is a beautiful sailer, too. Grumman kit includes rudder, leeboards for stability, a mast step, and nylon sail—lateen rig (shown here) for canoes to 15 ft., a Gunter rig for larger ones.

TOP-DOWN FISHING

Take the whole gang along when you run with the big Formula 233. She's available with twin 170 stern drives for nifty handling when the action's hottest. Fast, comfortable, and able.

Glamorous warrior is Trojan's 25-ft. Marlin, a flush-deck inboard for up to 225 hp. Nine-ft. beam; two bunks and a private head forward. Handles four game rods with ease.

When a feller needs his own fishing boat, a rig like this is in order. MFG fiberglass, it has a molded-in bait well and rod holders. This is an easy-to-handle boat with four-hp Merc motor.

Easy to take—both fishermen have padded swivel chairs in this 15-footer by MFG. Center console has a built-in ice chest; sides have storage racks for tackle or skis. It's Johnson-powered.

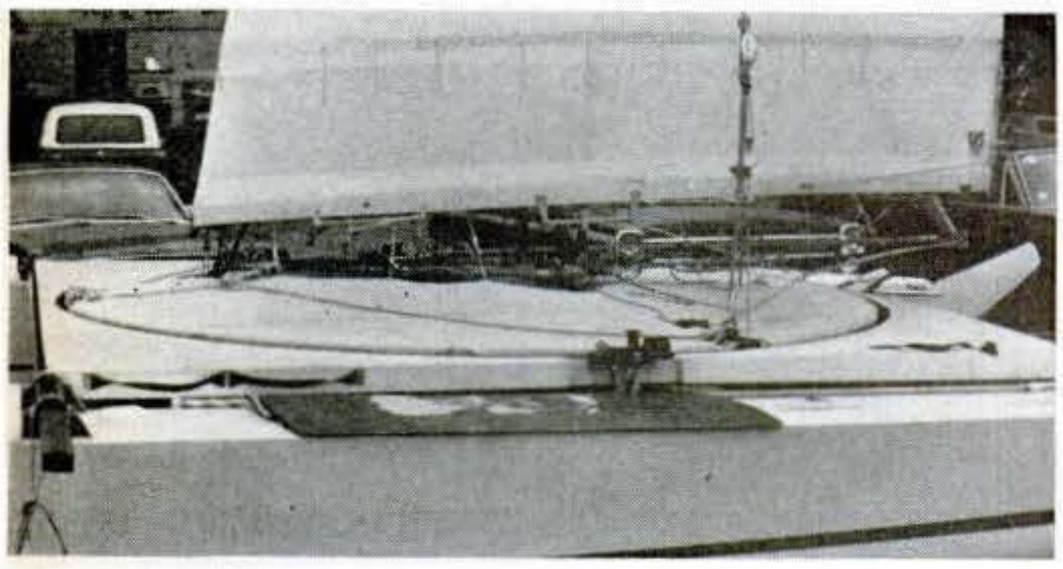
And still the champ—the classic aluminum car-topper, this one in lapstrake style by Chrysler. The 14-ft. version here weighs 117 pounds; a 12, only 94 pounds. Motor: Chrysler's tidy 12.9.

DREAM STUFF

Skeek Pacemaker 28 is designed for cruising or following big game offshore. Hull responds like the family sedan, and below decks you'll find a bright dinette-cabin.

Bertram 28-foot sportfisherman is also a sweet ship for cruising and entertaining. Strongly built, with great speed and rough-water ability, it has every refinement.

A Storm of New Ideas from Sail-Power



Wingsail and mast-stays rotate on a 360-degree turntable to save time and stress. Note the fiberglass "aileron" at tip.

Entire wingsail hinges to "furl." Collapse on a test run took Patient Lady out of '71 races for top Class C cats.

Rotating Wingsail Changes Shape to Move Cat Fast

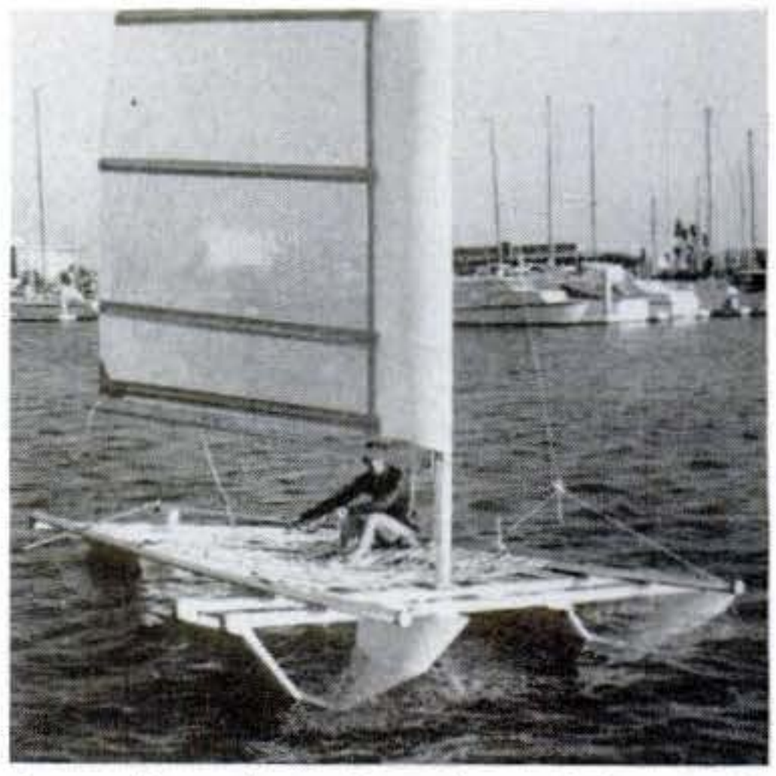
One of the most advanced racing sailboats in the world is the 25-foot C Class catamaran Patient Lady II. This cat has innovations that may revolutionize sail racing. Many are aircraft-type features.

The sail is actually a 38-foot aluminum-structured wingsail with two sides, fully battened, that can be adjusted to airfoil shapes by deck controls. It can be equally shaped, like a laminar flow wing, or set concave or convex on either side.

The wingsail stands on a turntable deck section, which lets it turn as a unit (unlike a wingmast rig). Principal advantage is to let the sail come forward rapidly when jibing downwind.

I saw this boat moving with incredible ease and control. Designer David Hubbard of Stamford, Conn., estimates she will easily go 25 knots. Knifelike hulls are hollow fiberglass. She takes a team of two.

"Sailing is never going to be the same," said multihull authority Robert Harris when speaking of the Lady.—*Ben Kocivar*



Stern view shows how foam foils supply buoyancy. Sail is see-through plastic.

The 23-foot wingmast dismounts, and two people can carry the 16-foot sailer home.

No-Hull Hydrofoil Moves in Any Kind of Wind

An ingeniously simple approach to more speed in small, inexpensive racing sailers is this wraithlike craft built by Gary Seaman of Venice, Calif. His hydrofoils not only lift to their tips at speed, reducing drag; they provide all the buoyancy, so there's no hull to slow takeoff from the start. She goes 19-21 knots.

Three V-shaped foam foils are joined by a take-apart frame of three-inch aluminum tubing. Design calls for a canvas deck, but webbing (see photos) will do.

With no hull and weighing a mere 150 pounds, Seaman's sailer can move in almost any wind. Still experimental, configurations and controls have not been finalized; but almost anything seems possible.—*Jim Davis*

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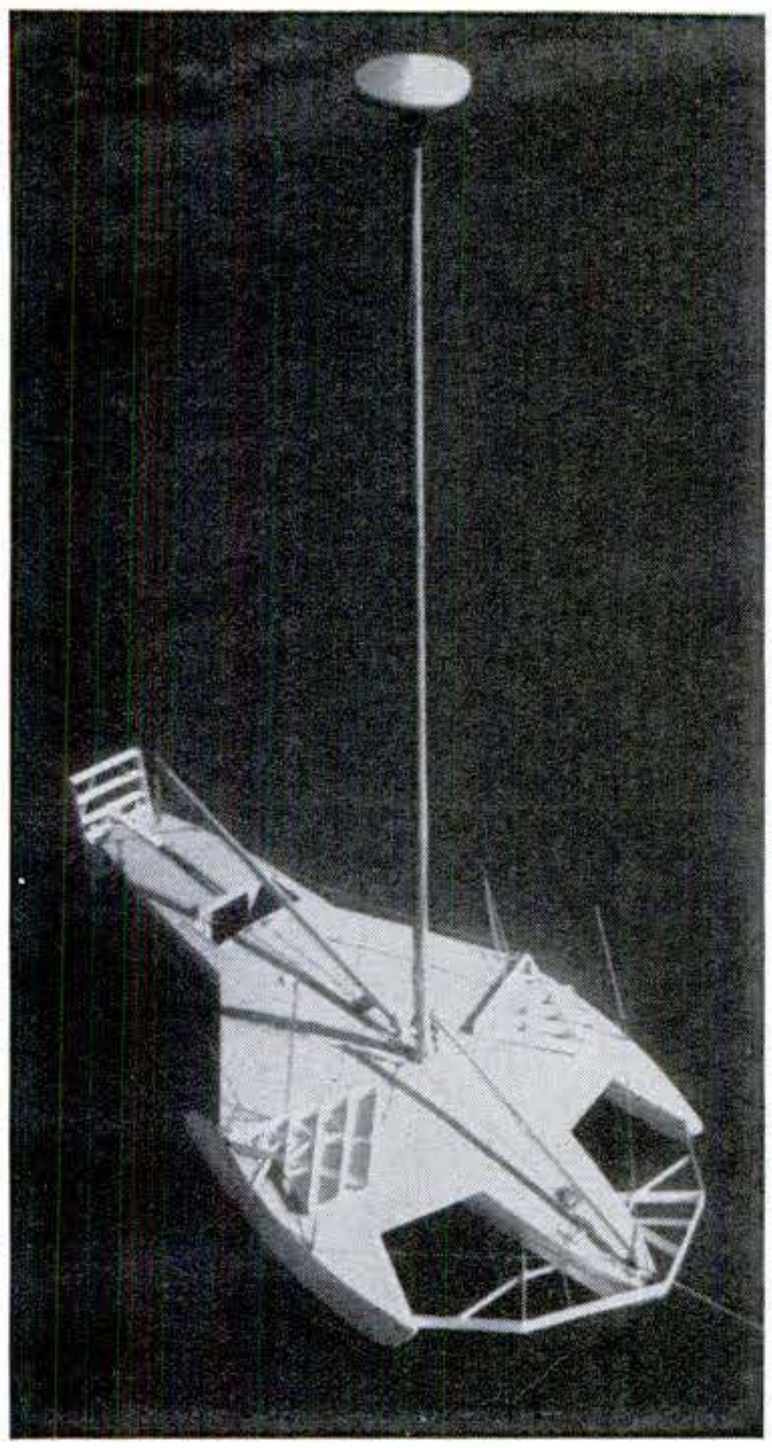
Designers



Aerial view of 31-foot trimaran at anchor shows foils retracted Cockpit is aft.

Flying on foils, Williwaw races ahead of conventional trimarans, reaching speeds of 20 to 30 knots. A float tops its 34-foot mast to prevent turning over if capsized.

Big Hydrofoil Trimaran Takes to the Air

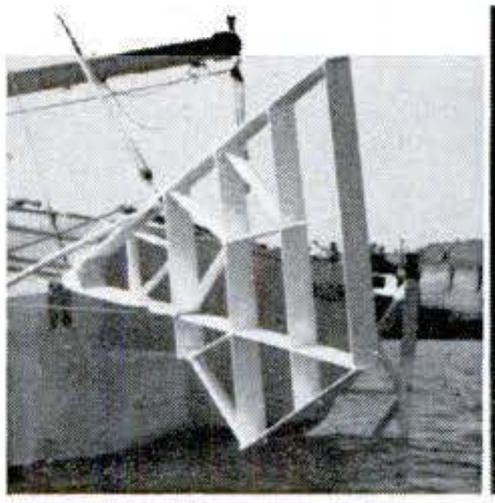
The sloop-rigged hydrofoil trimaran Williwaw is no baby. I began work on the design nine years ago and started construction of a 31-foot prototype in 1966. After three years of tests, including a 500-mile shakedown cruise off the California coast, Williwaw made the pioneer ocean voyage for such a craft in September, 1970, sailing from Sausalito, Calif., to the island of Maui, Hawaii. Self-steering and very smooth when foilborne, she's an efficient voyager.

Performance? She can reach 18-20 knots in a 15-knot true wind, and is usually fully foilborne above 13. With a heavy sea swell aft, she can go fully foilborne in almost no wind, running at the speed of the wave.

There are four hydrofoil lifting units: at bow, stern, and on each side, set wide of the pontoons. The foils are in fixed position when in use, except that the stern foil pivots for rudder action. There's no gadgetry to malfunction. Overloading the sail with side forces at high speed makes her nose down a degree and reenter the water. The foils know what to do.

The foils are made of welded aluminum, using an airfoil extrusion for the lifting elements. Hull is marine plywood, and fiberglassed. It was engineered for use with the hydrofoils—lightweight, but extremely rigid and strong.—*David A. Keiper*

Note: With his design parameters established, Keiper expects to build hydrofoil sailing craft from 16 feet up. For those who want to build their own, hull plans and a set of hydrofoils can be supplied for about 25 percent of the complete boat price. Write to Hydrofoil Sailing Craft, Box 71, Sausalito, Calif.



Beam foils add over eight feet of righting arm when lowered into "flying" position, help prevent a knockdown in hard gusts.

Huge hydrofoil swings over bow intact. Monocoque hull has a deep cockpit and spacious interior with bunks and galley.

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The size creates excitement when you pile power on a little boat. Scat-a-Boat, made by Craftline Industries, Algonac, Mich., does 33.3 mph with 20-hp outboard and two people. The 11-foot, 200-pound hull has a narrow 48-inch beam for speed and handling.

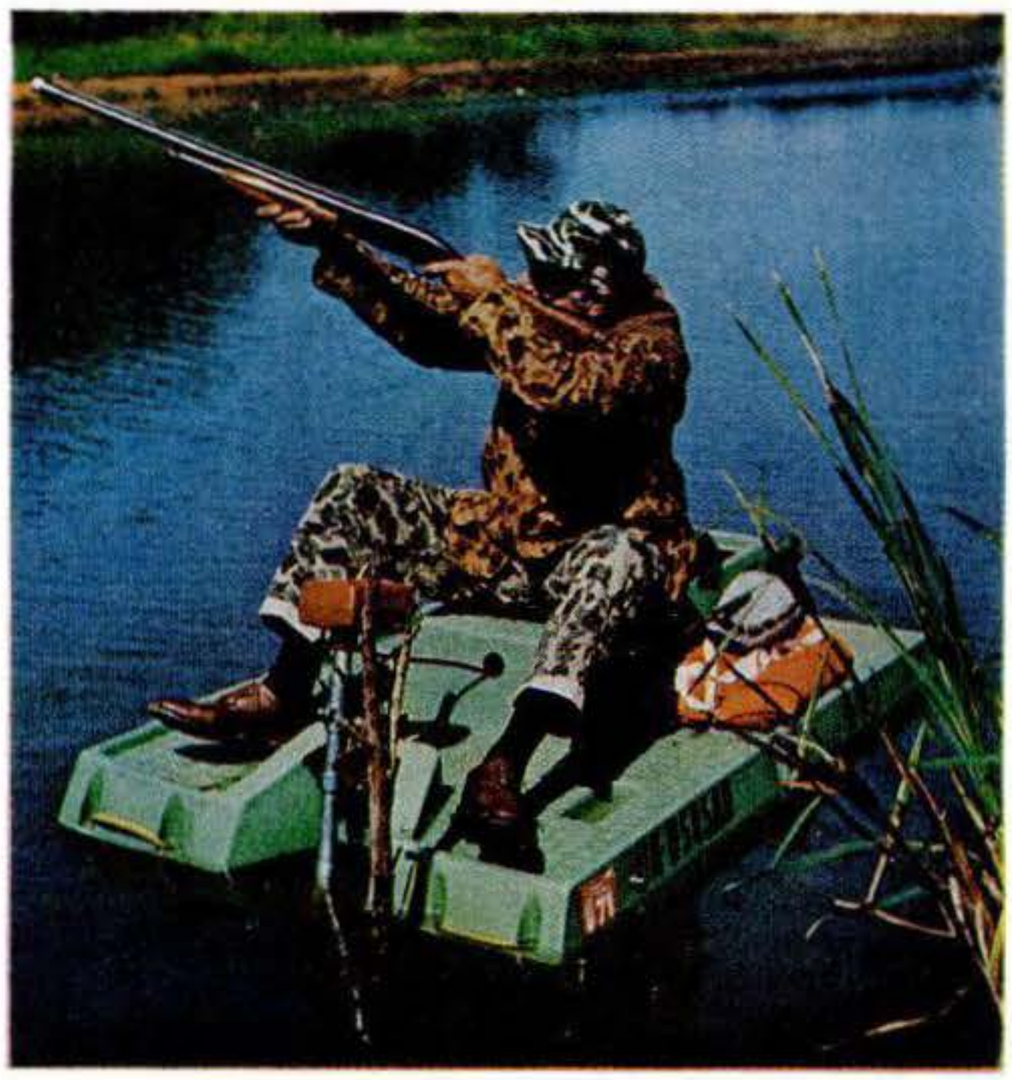
1972 BOATING

People-Size Boats

New concept gives you the ultimate in easy handling, with the lowest price for the purpose

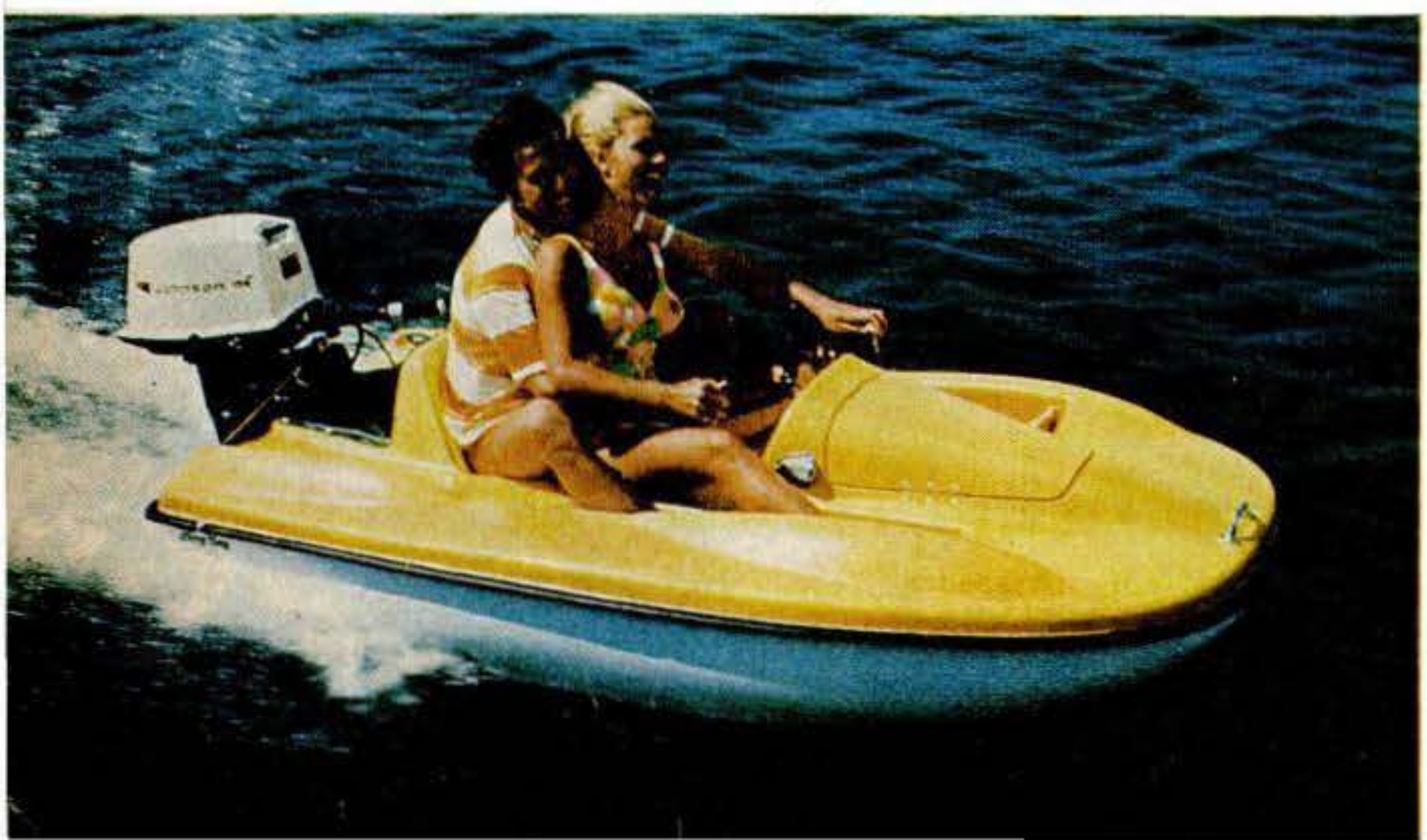
By DAVID D. VIGREN

What must be the quietest boating boom ever is the arrival without fanfare—but everywhere—of the little lightweight fun boats. They are built just big enough for one or maybe two people, with nothing wasted. Not toys, however, they do a real job—but without a lot of handling and expense. Some are designed for fast scooting on the water; others suit fishing, ferrying, or just puddling around. In shallows and on bassy ponds you can lift one where you can't run it. Most can be transported in a station wagon, camper, or inside your big trailered boat. Illustrated here is only a small assortment of those available. But whether as a second boat or miniboat, the Water Wagon at 20 pounds and $60, for instance, or the fast Scat-a-Boat at $595 equally make sense. PS

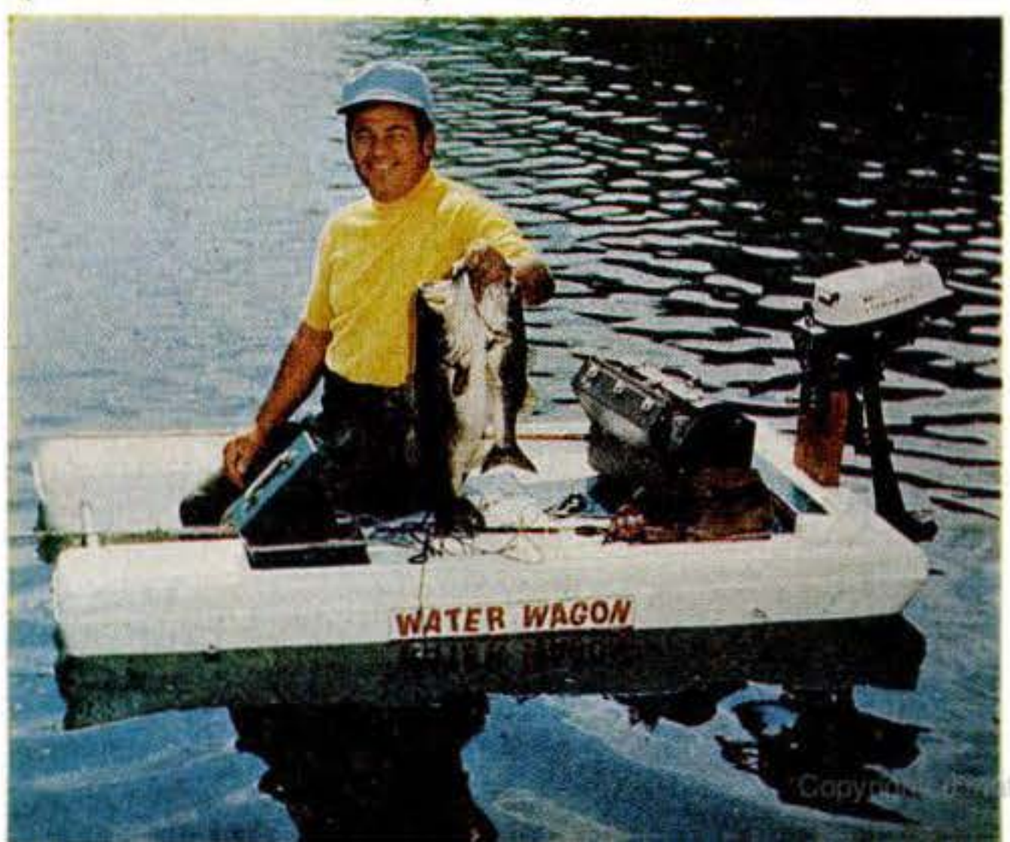


You assemble two pontoons and a center section to float the Basshopper, made by Jack Raft, Inc. Power is front-mounted electric troller. Weighs 85 pounds, costs $149.

Rubber-bumpered and fast, the eight-foot four-inch Sting Ray from Marine Unlimited of Warren, Mich, is typical of the scooter design in fun boats. Hull is ABS plastic, and it mounts a 20-hp Johnson outboard.



Propel the Water Wagon by kicking your legs, or use a midget motor—it's as much as the angler really needs in quiet waters. Made by Teckla, Inc., Amarillo, Texas.



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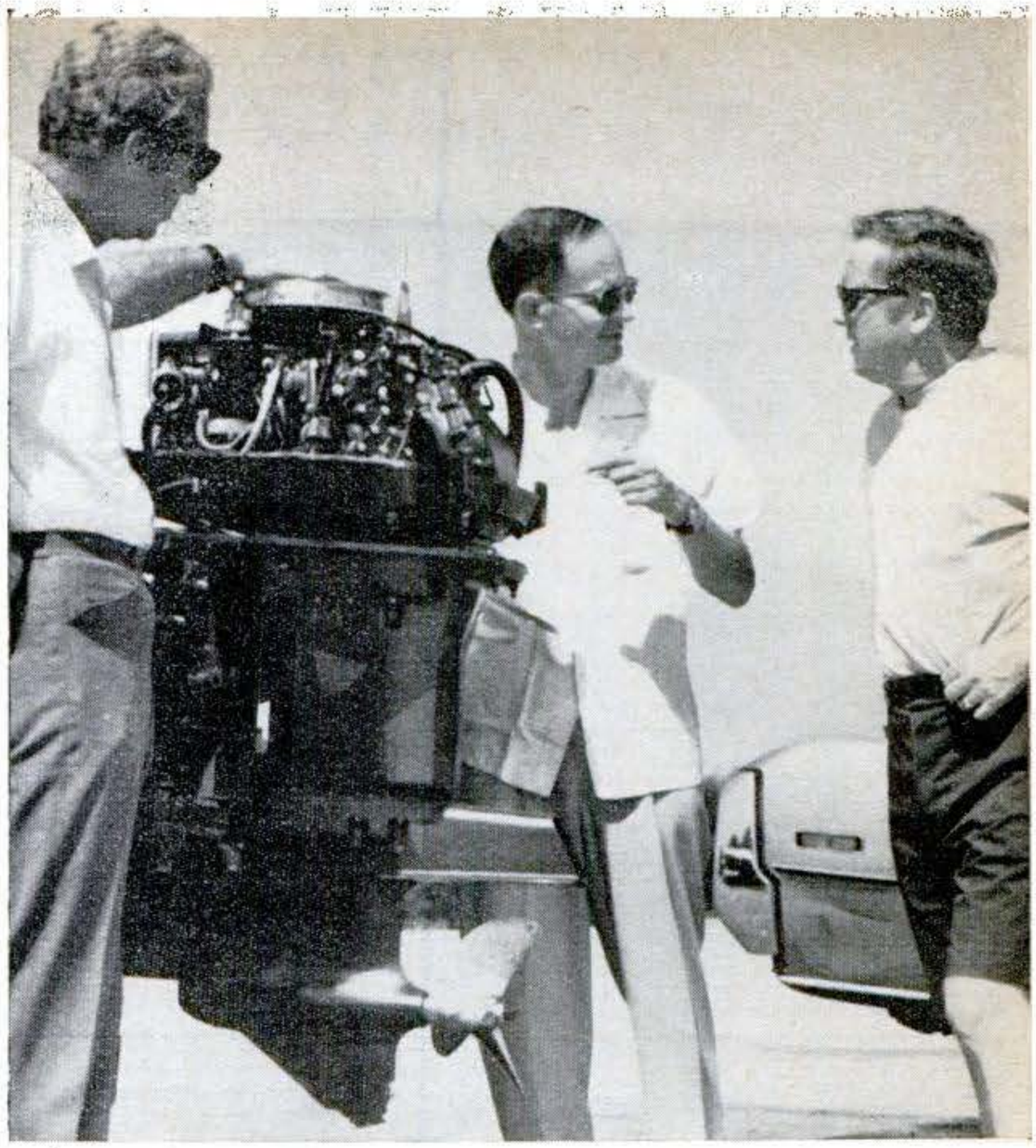
New Outboards: Better Neighbors Than Ever

Wide-open racing is a tough testing ground. What the engineers learn there is used to improve your outboard.



A far cry from the first engines—noisy, inefficient, and failure-prone—today's outboard is quiet and efficient, and will last for many years.

Cleaner, quieter, smoother-running—the new outboards are built to enjoy

By **JIM ROE**/*PS Boating Editor*

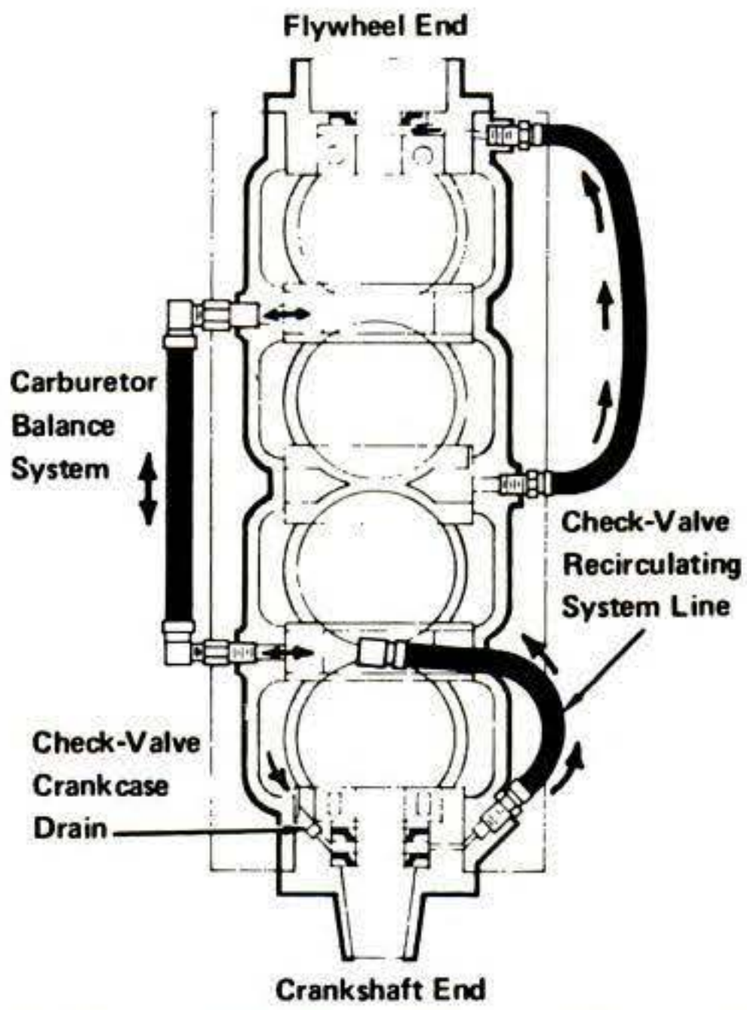
Your best neighbors are quiet, thrifty, clean, dependable, and fun to be with. In these days of ecological awareness, you'll find that the outboard engine stacks up as a pretty good neighbor, because:

- Modern outboards are quiet. Acoustical muffling devices, through-the-hub exhausts, rubber vibration mountings, and noise-inhibiting cowlings make outboards one of the quietest group of engines around.
- Today's outboards are thrifty. A few years ago, the common oil/fuel mixture for outboards was 1:6. Today it's 1:50—which means that you spend less money for oil. New capacitor-discharge ignition systems provide greater fuel efficiency, and make spark plugs last up to 10 times longer than before.
- New outboards are clean. For many years Lake X in central Florida has been the main on-the-water testing facility for Mercury outboards. The lake is 15,000 feet long, 7,400 feet wide, and has an average depth of 12 feet. Test drivers have been operating boats day and night there for 10 years. Three million gallons of fuel and oil have been burned in those 10 years—equivalent to more than 681 boats operating 100 hours a year.

Environmental Engineering, Inc., studied the effect of this intense boating activity on the quality of the water. Gas chromatography measurements revealed no evidences of contamination by hydrocarbons. Studies of the water and sediment in the lake bottom showed that the phytoplankton and bottom organisms that are necessary in the healthy ecological chain were not affected by exhaust-water hydrocarbons.

Beginning this year, all two-cycle outboards made by all major Ameri-

[*Continued on page 146*]



Drainless crankcase (above) recycles unburned fuel condensed in crankcase. Better cylinder design (right) improves scavenging. Curved piston deflector makes fuel-air charge travel to top of combustion chamber and down, scavenging spent gases.

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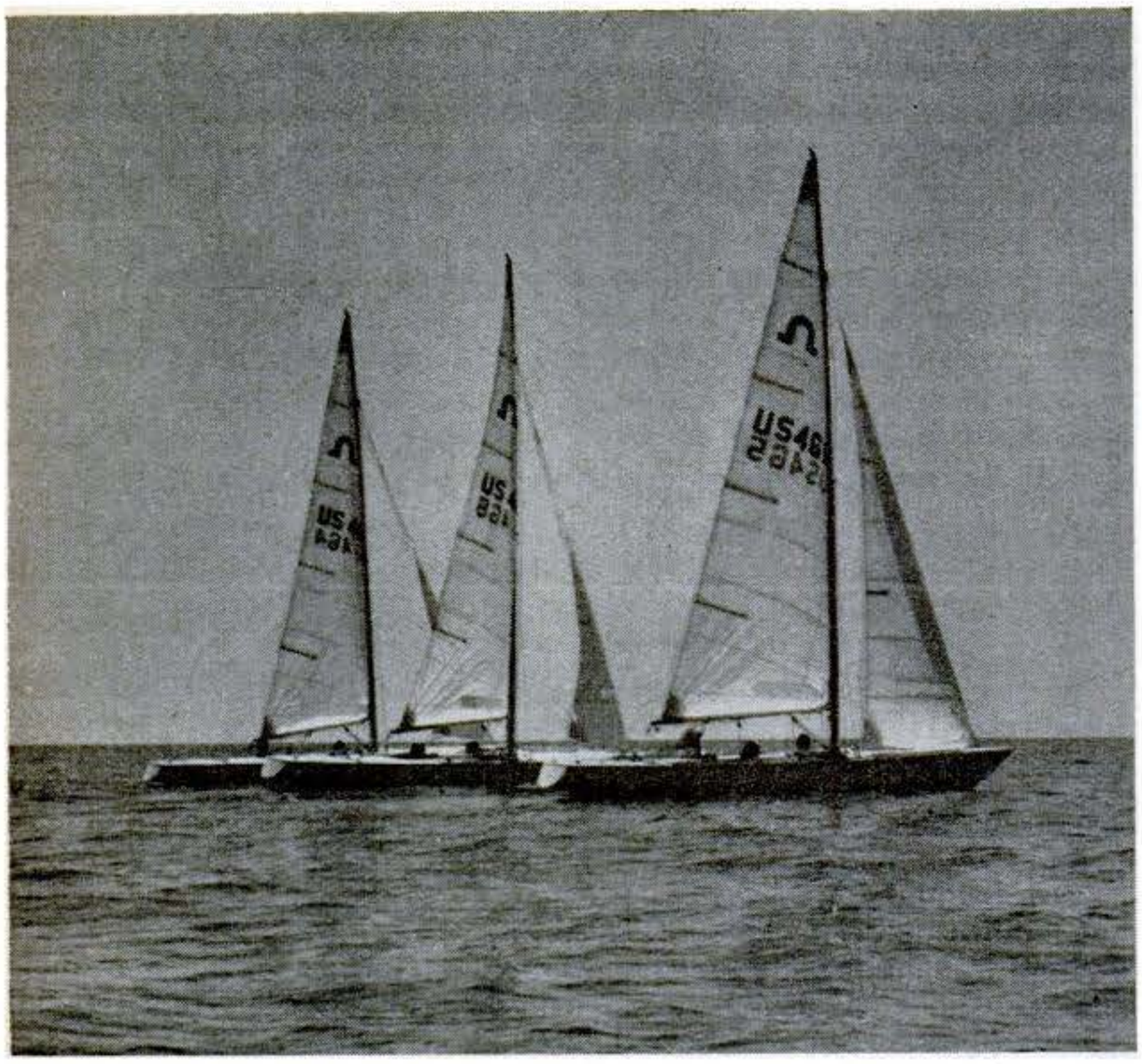
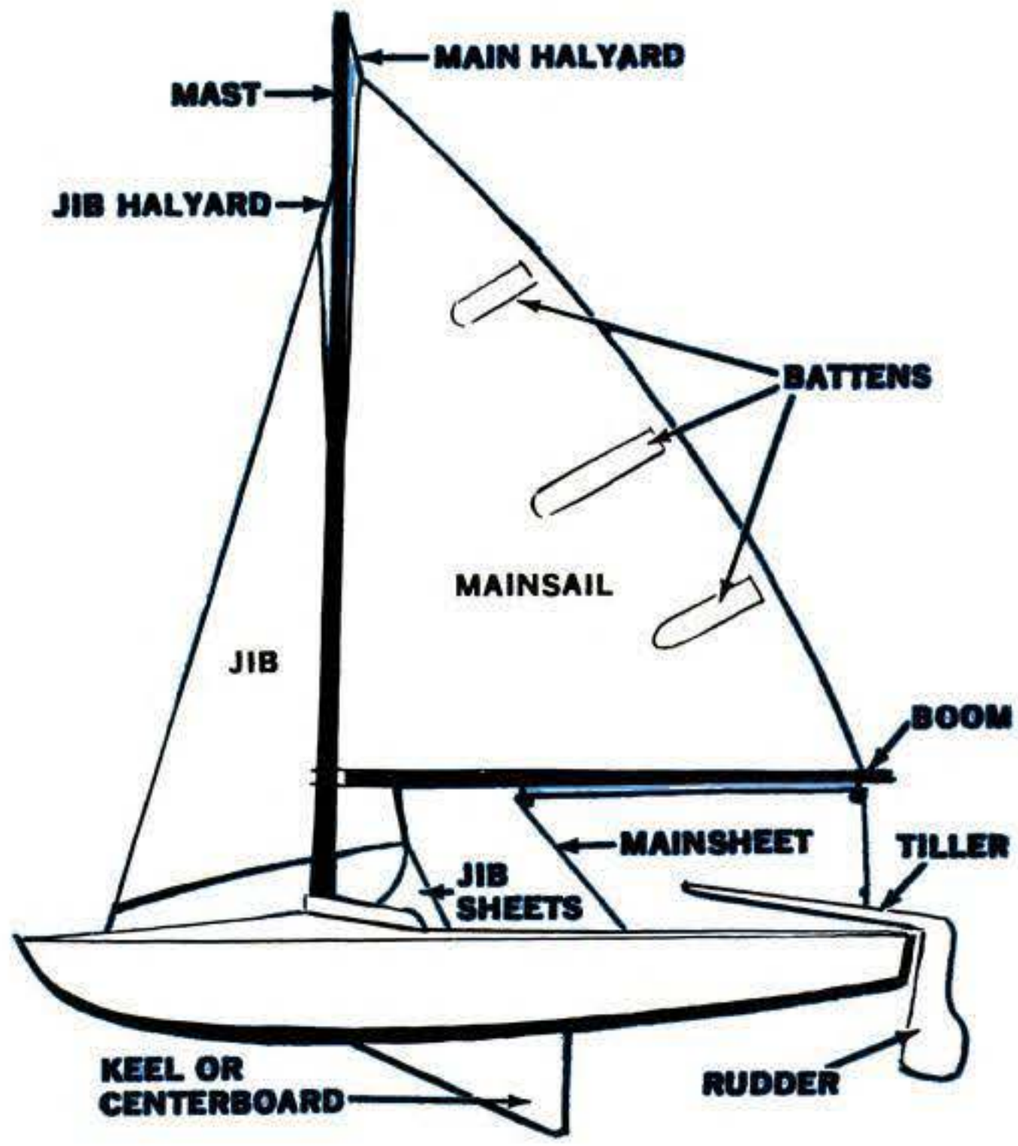
READY ABOUT—Let's





On one of the 27-foot boats above, Hill learned to sail. The basic parts of a sailboat are illustrated at right. Mainsail and jib: They convert the wind's force into forward motion of the hull. Jib and main halyard: Wire cables used to raise and lower the sails. Battens: Wood or plastic slats inserted in the mainsail to help give the sail shape. Mast: It supports the mainsail and jib. Mainsheet: Line used to control the mainsail's angle to the wind. Jib sheets: Two lines used to control the jib's angle to the wind. Boom: Pivoting around the mast, it holds the bottom of the mainsail. Tiller: It's used to turn the rudder. To turn the boat to the right, push the tiller left, and vice versa. Keel: It prevents the boat from moving sideways.

Sailing's one of the oldest activities in the world. If you don't know how to do it, you're missing a lot of fun

By RAY HILL

Ever stand on shore during a sunny day and watch racing sailboats majestically round a distant marker—wishing you knew how to sail? Quit wishing. You can learn fast in sailing school. When I went to my first sailing class I had never been aboard a sailboat. Four days later I rigged a 27-foot Soling and sailed away from the dock without an instructor.

The sun was warm, and the water spray pleasantly cool as it broke over the bow and splashed against me. My hand rested on the tiller and made a tiny correction as the wind shifted slightly. I was the skipper, using the same principle that carried Magellan around the world centuries ago—wind against a sail.

I was on a boat owned by the Offshore Sailing School (5 East 40th St., New York, N.Y.), one of many schools across the country that will convert you from a 10-thumb landlubber into a salty sailor.

For $145, Offshore provides you with six days of sailing—four days under the watchful eyes of an instructor, and the last two days by yourself. During the first four days I learned how to attach and hoist the sails, and how to get underway and stop the boat.

Getting underway is easy. After hoisting the sails, you untie the boat from the dock, and push the jib to the port or starboard side until the sail catches enough wind to push the boat around. When the bow's pointed in the direction in which you want to go, haul in the sheets (lines that control the angle of the jib and the mainsail to the boat's centerline) until the sails are at the proper angle. To stop the boat, you just let the sails out until the wind isn't pushing them any more, and use the tiller to turn the boat into the wind.

You can find a sailing school by looking in the yellow pages of your telephone directory under "boating instruction," or by asking at a marina or yacht club. Once you've learned to sail, you'll have a hobby you'll never want to give up. PS

When your destination

Jibing—sailing downwind while you let the boom move from one side of the boat to the other. You do this to change direction. To jibe, pull the tiller in the direction of the wind (A). As the boom swings across the boat (B), lower your head to prevent getting hit by the boom, and pull in the mainsheet as rapidly as possible to keep the boom from sweeping wildly across the boat. As the boat approaches position C, ease out the mainsheet until the mainsail is in the appropriate position. When jibing, the jib sheets are loosened and the jib is allowed to swing over.

When your destination

Tacking—another way to change a sailboat's direction. Basic difference between tacking and jibing is that boat is headed downwind when jibing, and upwind (D) when tacking. The tack should be executed as rapidly as possible, so when the boat is in position E, headed directly into the wind, it will have enough momentum to move into position F without stopping. How do you know when your sails are at the right angle to the wind after completing jibe or tack? Let the sails out until they begin to luff (flop in the breeze) and then pull them back toward the boat's centerline until luffing stops.

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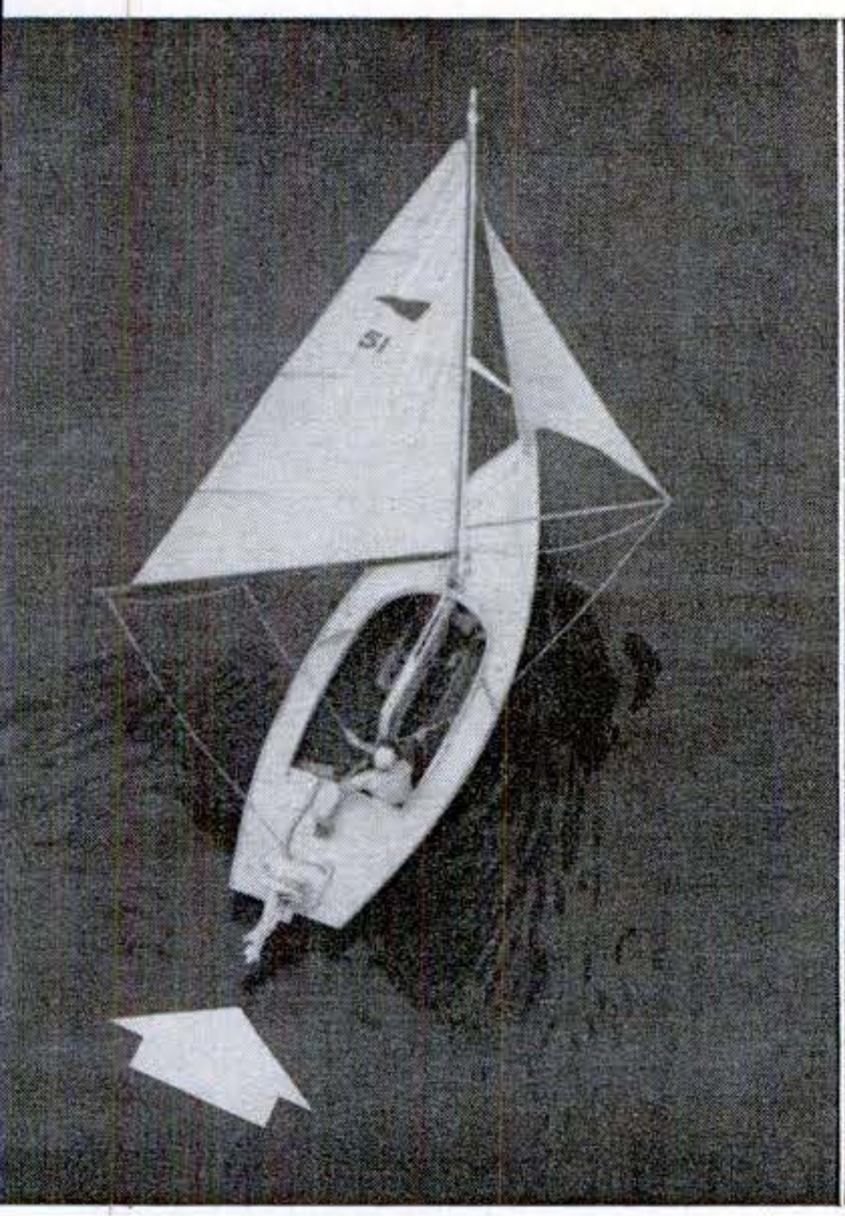
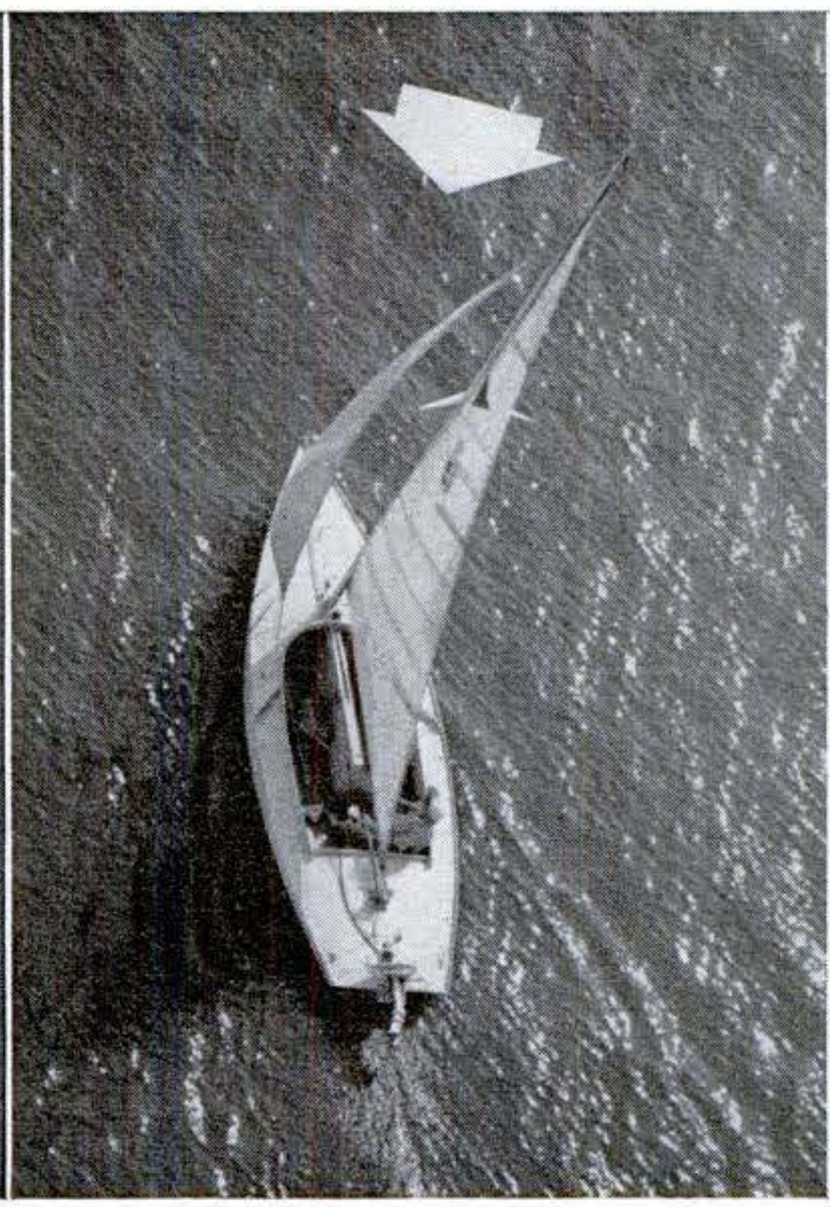
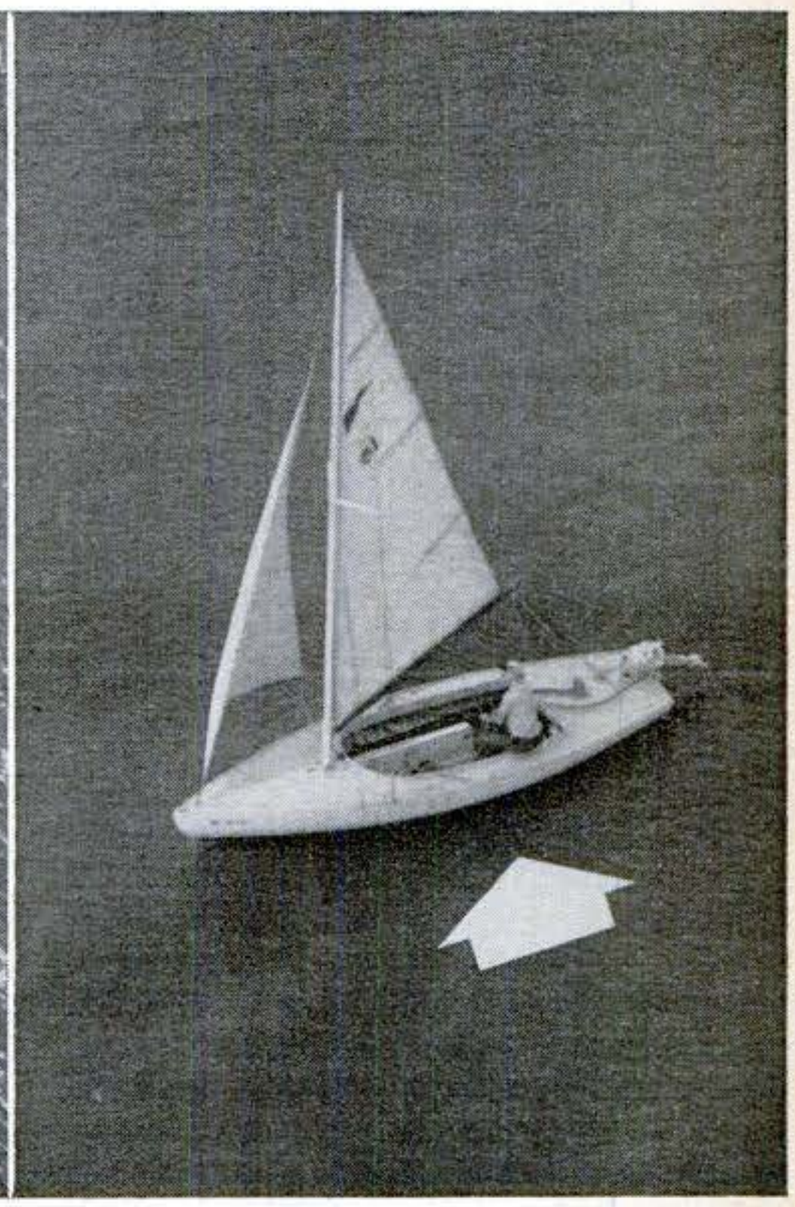
Go to Sailing School





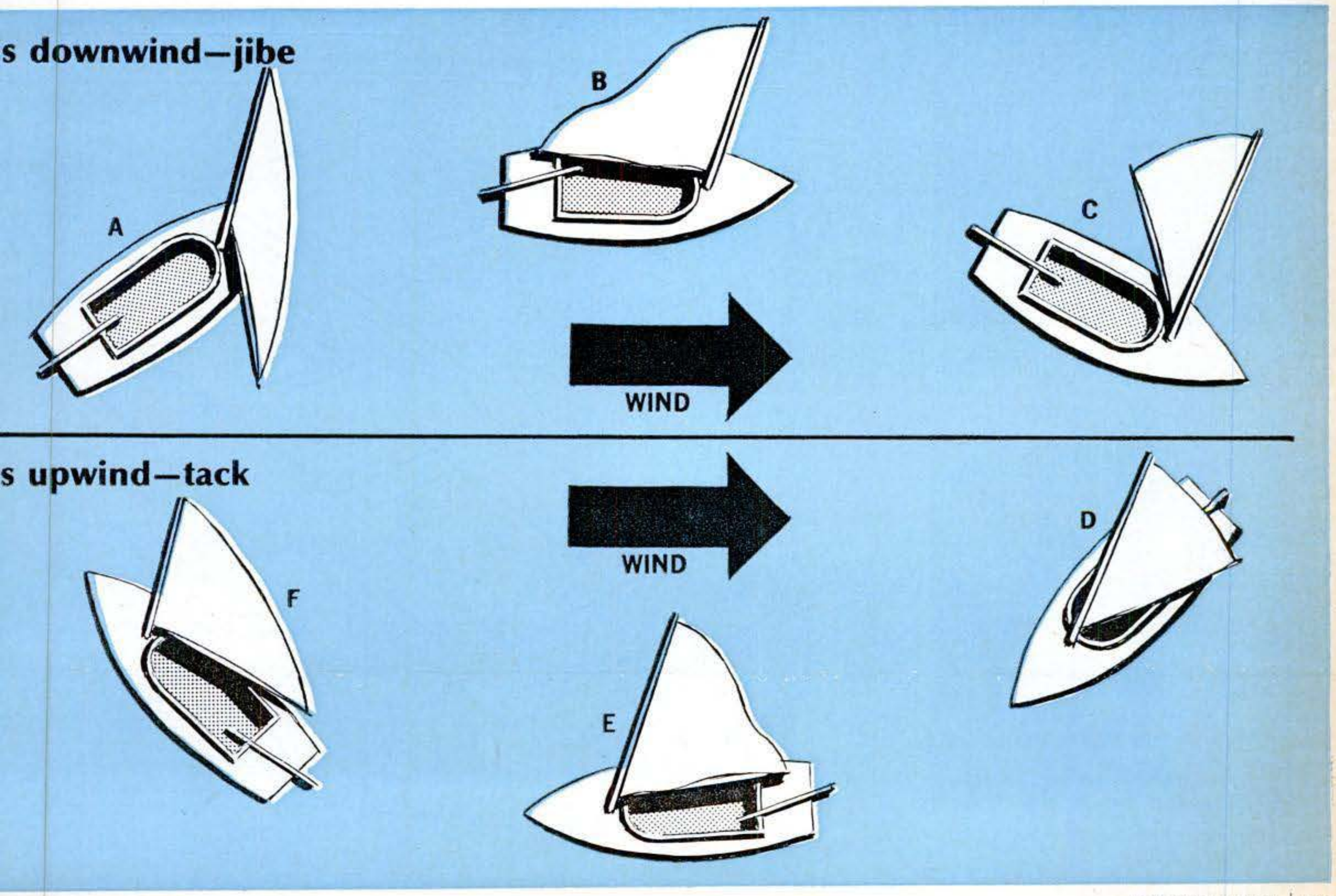


Points of sailing

Running—sailing with the wind directly behind you and the jib and the mainsail swung out until they're at about 90-degree angle to the boat's centerline.

Beating—sailing toward the wind, boat pointed at about 45-degree angle to direction from which wind is blowing. Sailing directly into wind is impossible.

Beam reaching—sailing with the wind blowing directly across the beam of the boat and with the sails at about 45-degree angle to the boat's centerline.



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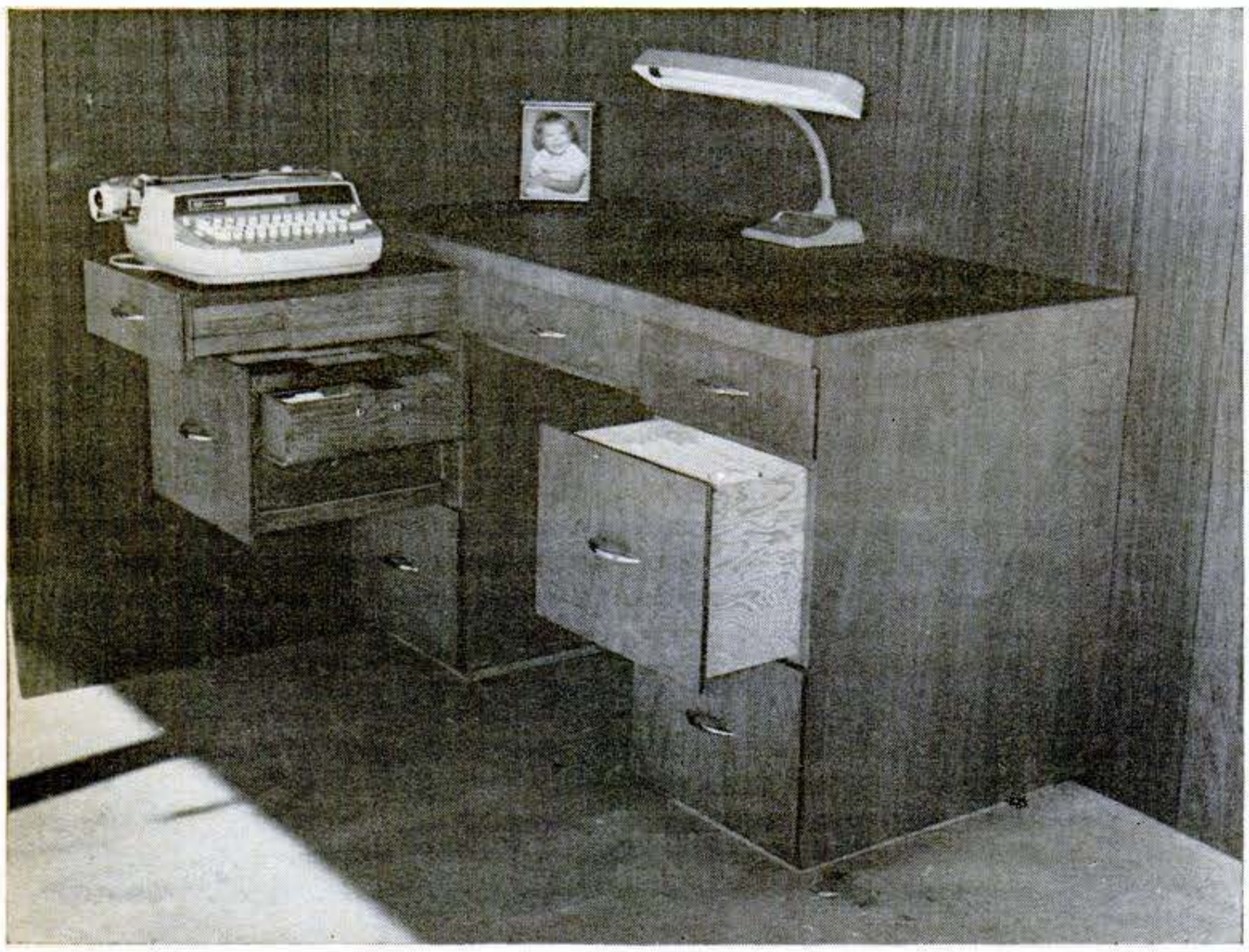
Easy-to-Build Desk:



Desk has typewriter pullout, file folder drawers, and side-of-drawer index-card storage (directly below typewriter) to put everything you need within easy reach.

By JIM ABBOTT

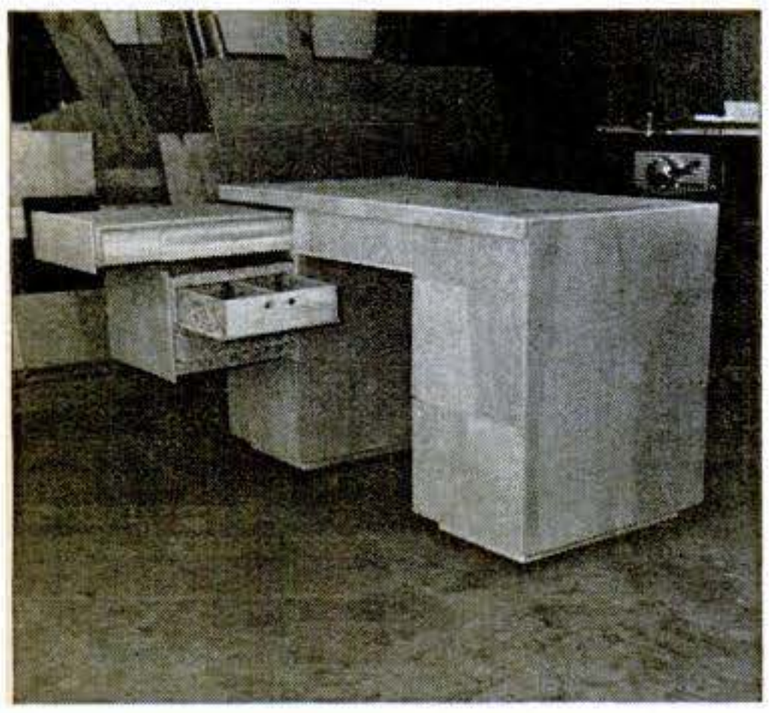
A good desk is hard to find. Locate one and it's hard to pay for. After a lot of searching and pricing, I finally decided to build my own. It's conventional in appearance, but conceals features that keep things at your fingertips in minimum space.

There's a pullout for a typewriter. Below that, nestled into the side of a large drawer, is a shallow drawer for index cards. Other drawers are sized to take file folders.

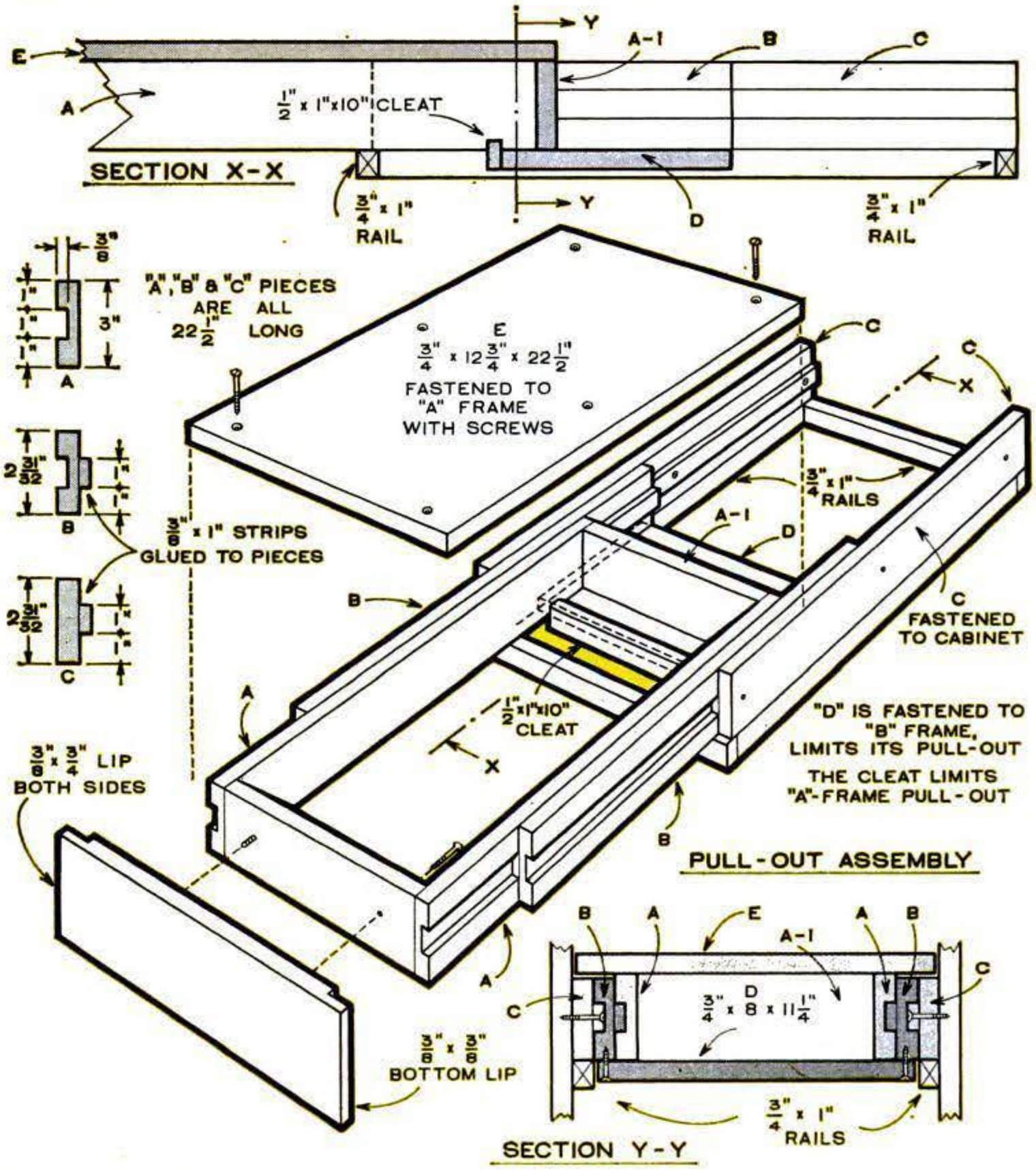
This desk is not a project to be tackled only by master craftsmen. I deliberately designed this piece of furniture with the average home-shop worker in mind. There are no fancy cuts or tricky joints, no expensive woods to match. The basic material is stock plywood, and total material costs ran me less than $50.

Round up your materials. The list—on the last page—can serve as a guide, but you may want to use different

To build desk, make two box-like pedestals, joining them with cleats. Top goes on with screws driven up through the cleats.



Drawer below typewriter pullout is inaccessible when pullout is in use, so author installed card storage in side of drawer.



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Everything at Your Fingertips

woods and finishes. Note that I've confined the width to 48". This will enable you to make all the parts from standard 4-by-8 plywood sheets and, at the same time, create a waterfall effect without piecing.

An attractively grained plywood such as birch or walnut can be used for the top, front, and sides. Less expensive fir may then be used for the other pieces if you want to keep the price down.

Cut out all the parts first. Follow the dimensions carefully. Especially critical is the top. Unless these rabbets are accurately cut the edges will not be a good match. In fact, if you can remove all but 1/16" of the top veneer in making these rabbets, all the better. But, be careful! That thin veneer is susceptible to splintering, both during and after the cutting. For this reason, I've allowed for a full 1/8" in the drawing. If you do decide on a 1/16" lip, be sure to correct the other sizes.

The basic plywood cuts may be made with a portable power saw on a cutting table, but once the sheets have been reduced to manageable size, switch to a table saw to ensure the utmost in accuracy.

The assembly. Begin from the bottom up, starting with the pedestal bases and fastening the bottom boards to these. Attach the side pieces next (drawer runners previously placed), using white glue at all joints and clinching with finishing nails, driven from the bottom up to avoid marring the sides.

Complete the "boxes" by attaching the drawer-runner fronts and backs, then the two longer cleats that will bring the pedestals into position for the top and center drawer parts.

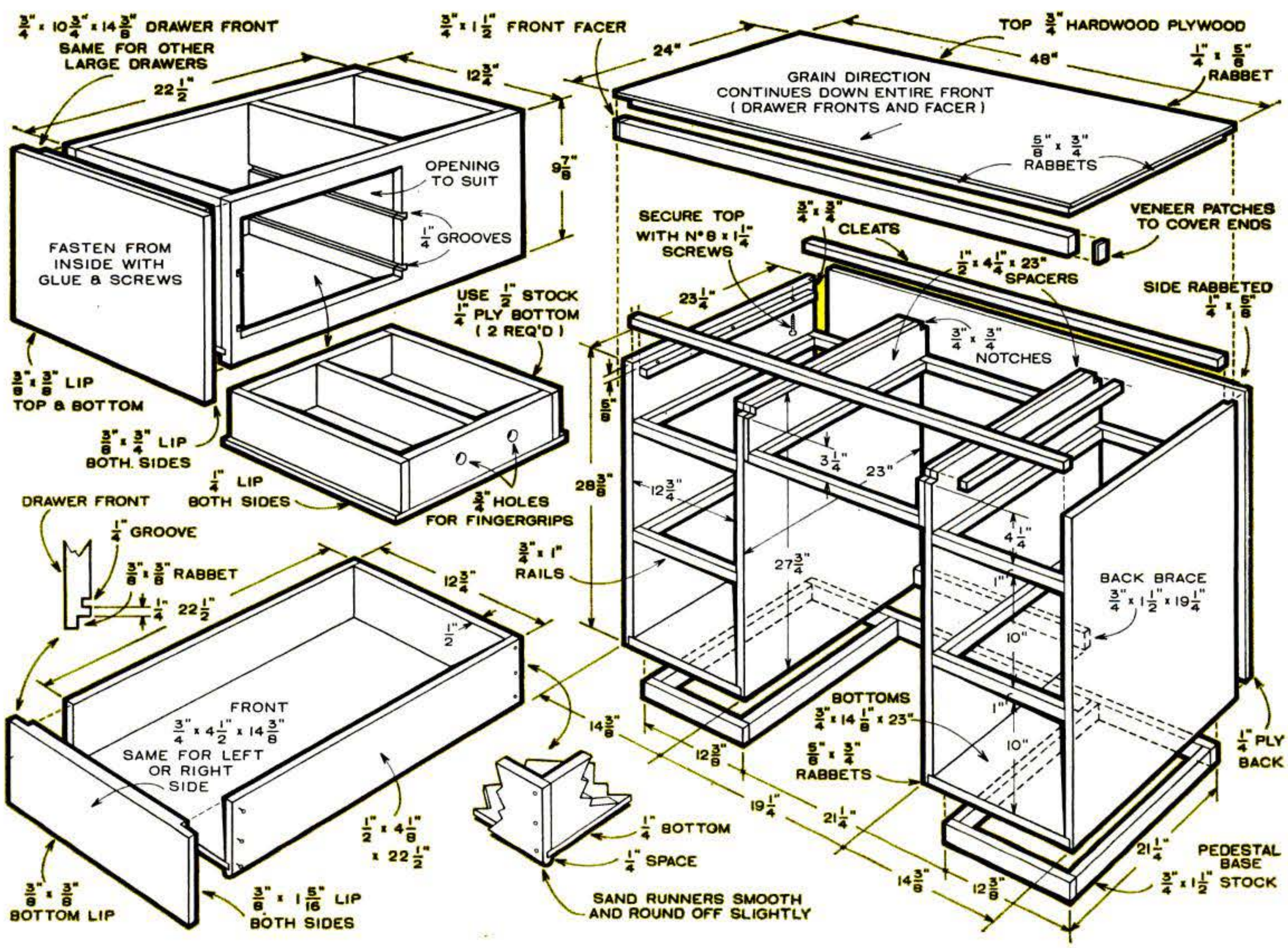
Test-fit the top and do any necessary sanding before applying glue to the top edges of the base. Secure the top with 1 1/4"-#8 screws driven upward through the cleats as shown. Next, apply the faceboard, using glue and clamps to ensure a neat, tight fit along the front edge.

Since the front parts of the base will be concealed by drawer fronts, it is not really necessary to cover the edges of the wood. Just fill in the flaws and holes with putty, sand smooth, and finish with the desired stain. However, you may want to glue veneer tape to these edges. The stuff comes in a variety of woods, in eight-foot rolls, and is easily applied with glue.

Drawer construction. This is largely a matter of preference. I used a simple, box-like assembly. Build the boxes as shown, then attach the drawer fronts with glue and brads. Remember that the "box" slides more easily when weight rests on the two side pieces rather than on the entire bottom, hence the grooved slots for the drawer bottoms.

The drawer just below the typewriter pullout on most desks is generally a lost cause unless you want to move the machine and push in the support whenever access is desired. To circumvent this problem I decided to put the openings in the side of a drawer, in this case sized for 3"-by-5" index cards. It would be just as easy

[Continued on page 136]



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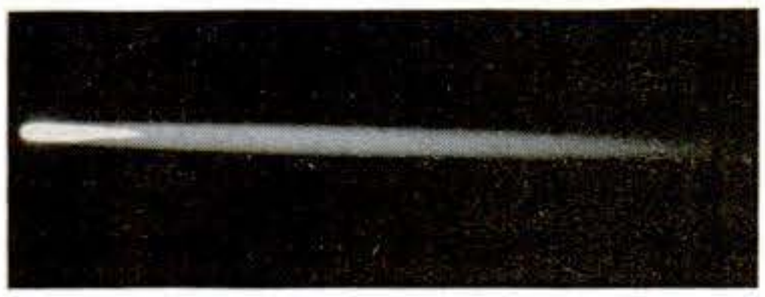
Welding Pitfalls You Can Avoid

Just getting started in welding? Don't let early mistakes become bad habits. Here are the common ones to guard against

By AL D. THIGPEN

Adjusting for neutral flame

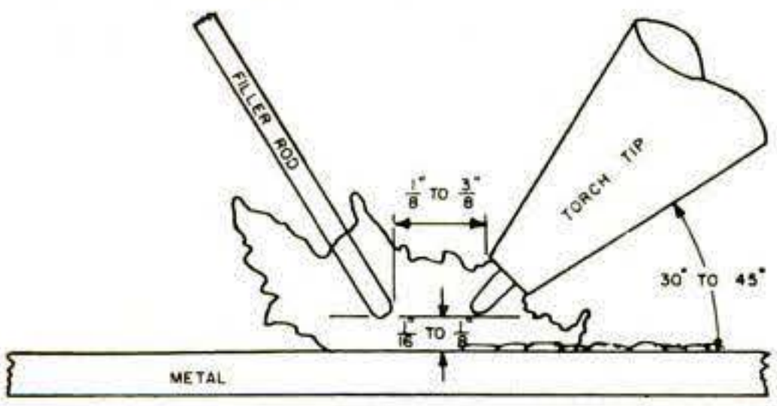
Start with pure acetylene, adjusted like this: ¾"-to-1" space before turbulence must be blue, separated by band of white.



Add oxygen to flame until middle cones disappear into inner cone. To avoid soot from acetylene, crack oxygen knob when lighting.

Neutral flame has single, round inner core. Adding less oxygen causes carburizing flame unsuited to welding—it makes metal boil.

Positioning torch and rod



USE RIGHT PRESSURES

METAL THICKNESS	WELDING ROD DIA.	TIP-ORIFICE SIZE	DIAL PRESSURE OXYGEN	DIAL PRESSURE ACETYLENE
1/16"	1/16"–3/32"	60–69	4	4
1/8"	3/32"–1/8"	54–57	5	5
1/4"	5/32"–3/16"	44–52	8	8
3/8"	3/16"–1/4"	40–50	9	9

Welders with poor technique probably began to fall into their bad habits the very first time they picked up a torch. That's one of the first lessons I learned in my course at East Texas State University, recently. To weld right, you must learn right. Even if you have welding experience—with poor practices already ingrained—you can go back and start again.

Beginners inevitably make mistakes in one or more of these areas: flame adjustment, torch position and movement, rod selection and use.

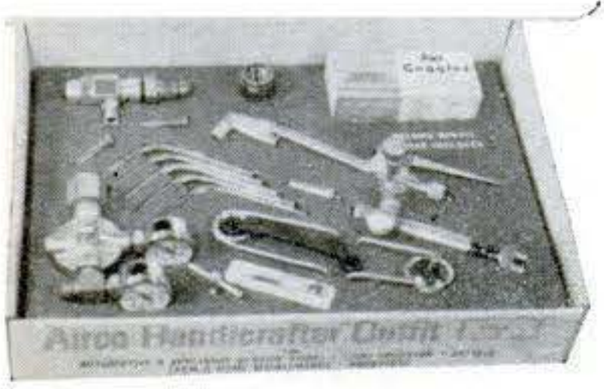
Proper torch adjustment. This is a must for good welding. The torch may be adjusted to obtain a *neutral* flame, a *carburizing* flame, or an *oxidizing* flame. Oxygen and acetylene gases are combined to form these various flames, but too much oxygen results in an oxidizing flame (oxygen combines with the metal), while too much acetylene produces a carburizing flame (carbon mixes with the metal). Therefore, the neutral flame is the most desirable of the three.

How do you get the right balance of oxygen and acetylene? And then, how do you know you have a neutral flame? First, adjust the oxygen and acetylene regulators to provide the proper gas pressures according to the metal thickness, diameter of welding rod, and tip-orifice size (see chart). Next, open the acetylene-torch valve about 1/16 of a turn and ignite. Then slowly open it until the flame jumps 1/16" away from the tip with the flip of the torch, or until the flame stops releasing soot and begins to get turbulent at a distance of ¾" to 1" from the end of the torch tip.

Now slowly open the oxygen torch valve. Adjust the oxygen until a smooth inner cone—the vital sign of a neutral flame—is formed at the base of the flame. If the inner cone is rough and irregularly contoured, it is a carburizing flame because too much acetylene is being used. If the inner cone is sharp and the flame hisses loudly, it is an oxidizing flame. A soft purring sound will be emitted by a neutral flame and you should be able to grasp the torch tip ¼" to ½" from the flame base without its being hot.

Learn to puddle. The next area that gives many beginning welders trouble is "puddling." If you can't puddle, you can't weld. Getting a good puddle—or trail of molten metal—is dependent on the welder's ability to position and move the torch properly.

New equipment brings welding within reach of all home shops



Light-duty welding and cutting outfits, such as the one at left, make it easy to get started. Airco (P.O. Box 486, Union, N.J. 07083) offers a variety of kits for home shops—starting with the light-duty Minicrafter at $77. Our choice: the new $135 Handicrafter with two gas regulators, a torch with wide choice of heating, welding, and cutting tips, sparklighter, goggles, 12-ft. twin hose. Sears now catalogs a range of similar outfits, from a $97.50 single-stage up to a $168 super-duty.

Union Carbide's Linde Division recently added a self-igniting feature to their Prest-O-Lite brazing torch. You get instant ignition by squeezing a lever on the torch handle, freeing one hand for other use during lightup.

Perhaps the cheapest outfit for small-job brazing is a solid oxygen torch such as Solidox (Cleanweld Products, 9220 S. Atlantic Blvd., South Gate, Calif. 90280). Kits range from $24.95 (to convert your propane torch) up to $69.95 for a complete welding and cutting kit. PS ran a report on this kit in the Nov. '68 issue. Low-price electric welders were covered in a roundup in the Oct. '66 issue.

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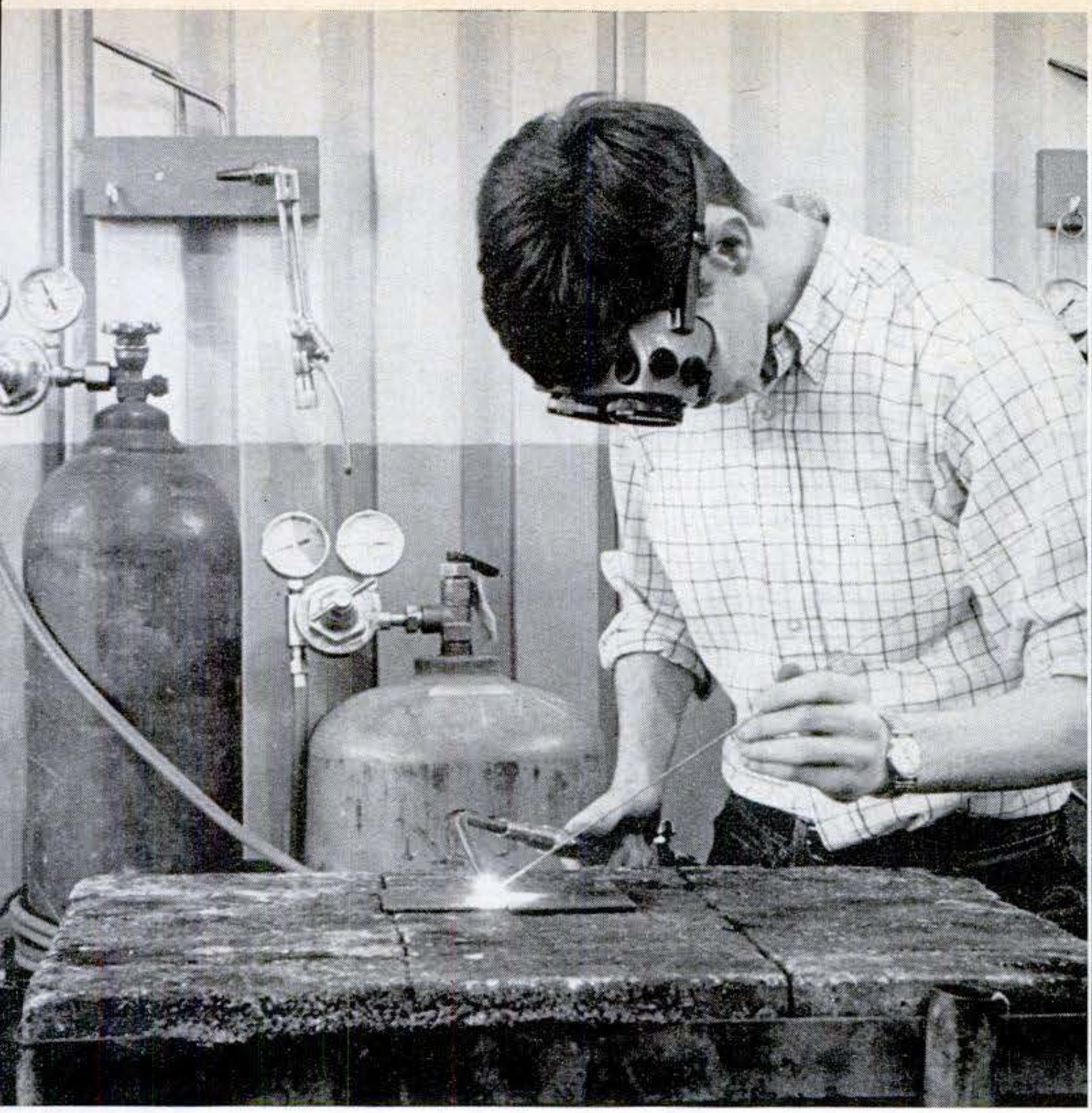

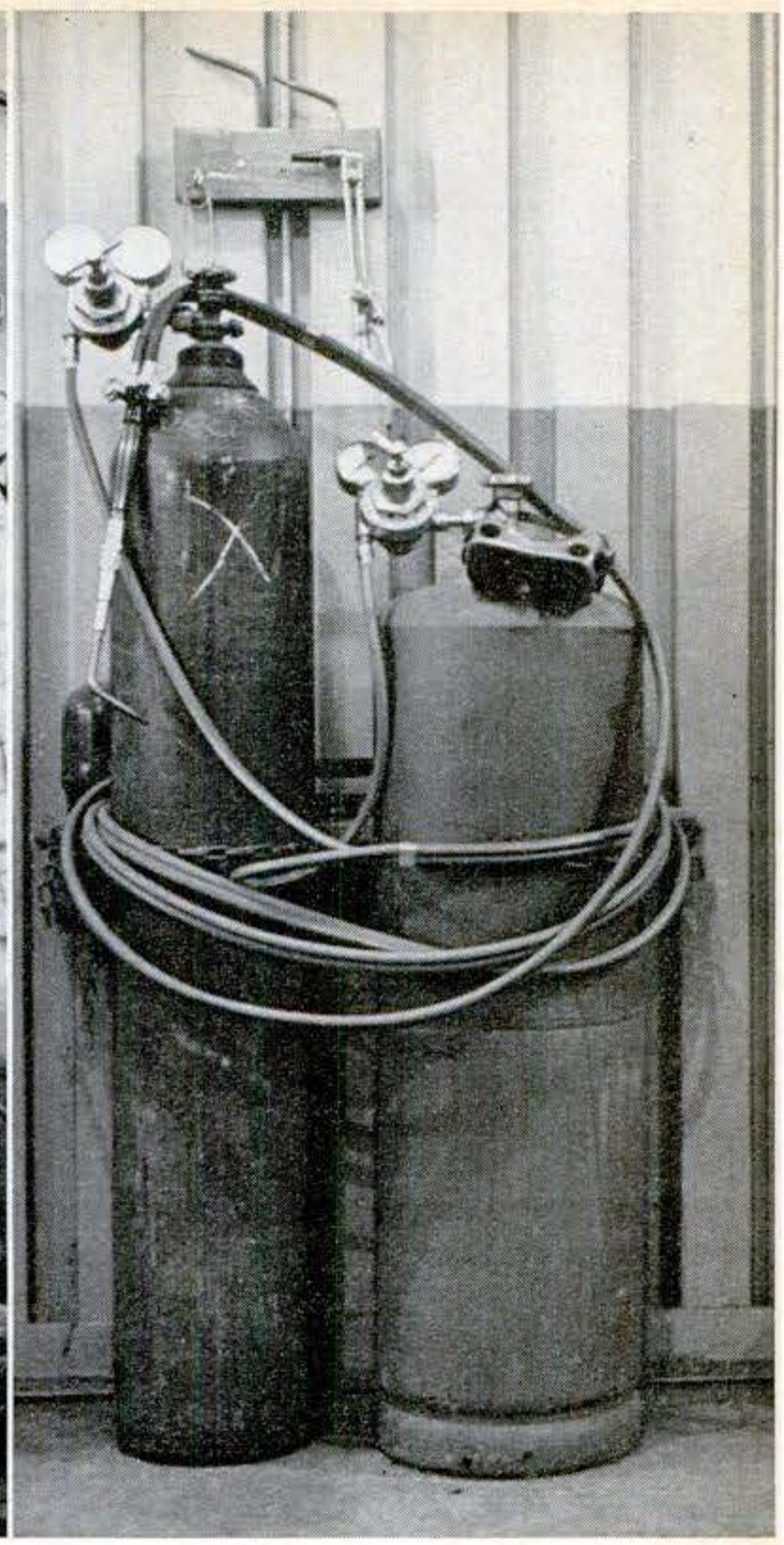

Complete oxyacetylene rig (in use above, stored at right) consists of an oxygen tank, an acetylene tank, regulators, hoses and torch attachments. Safety goggles are a must—as is a nonflammable work surface. (This article deals only with gas welding.)

The torch should be held at an angle of 30 to 45 degrees to the work. In this position, the flame spreads over the work ahead—preheating it for the approaching tip. The tip of the inner cone should be held 1/16" to 1/8" above the molten pool of metal. It shouldn't go outside the puddle.

Get the swing. Once you've mastered torch positioning, you must add good torch motion. It may be a circular or an oscillating motion, depending on which comes easiest to you. Motion of the torch is important because it controls the width of the puddle. When proper puddle width is obtained, proper penetration is also obtained because the depth of penetration is proportional to the width of the puddle.

A good puddle will have a small incandescent spot moving around the edge farthest from the torch. If this spot is oversize, it could be that you don't have a neutral flame. Also, a good puddle will have a smooth, glossy ripple. You can only judge these effects if you're wearing proper welding goggles—they're not visible to the naked eye.

You should practice making several beads or puddles until you can make them consistently and without a lot of concentration before confronting the next obstacle to good welding: the welding rod.

Choosing the rod. One of the biggest problems beginners have with welding rods is deciding which size to use. Check our chart for this. Note that the rod diameter varies according to the thickness of the metal and the size of the torch tip.

Welding rods are sometimes called "filler rods" because that is what they do—fill the weld with extra material so that a thick, slightly convex weld is made. In contrast, puddling without a rod makes the welded joint slightly thinner than the welded pieces. Generally, a rod is used with all welding except when welding an outside corner or flange joint.

Using the welding rod is a little tricky until you learn to coordinate torch movement and rod movement. At the place where the weld is to begin, heat the joint until a puddle appears and the two materials flow together. At the same time, hold the rod 1/8" to 3/8" from the flame and about 1/8" above the puddle.

Controlling the melt. When more material must be added to make the puddle slightly convex, dip—don't drip—the rod into the puddle, while continuing the torch motion without interruption. Because it's preheated by the flame, the rod melts easily when inserted. If it is held too far from the flame, it might cool the puddle when it is added. On the other hand, if it is held too close to the flame, it will melt and be blown onto the metal ahead. It's tempting to melt the filler rod onto the joint without first bringing the two metals to their melting point. Make sure the base metals melt and fuse or the weld won't hold.

These are common errors of beginners, but there is one more thing that separates the good welder from the poor one: practice—lots of it!

There's no reason why you can't teach yourself if you can cultivate a self-critical attitude. If that's not your style, then try formal instruction. Most high schools offer welding courses in their auto or farm shop programs, and if you can generate enough interest in your community, you'll probably be able to get a course added to adult night classes. Also, welding companies often sponsor seminars at convenient centers such as garages and local auto-parts houses. It's a good way to get started. PS

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With drop leaves up, table seats eight. With the leaves down, it takes six. Center strip of marble is highly functional, stays in place between wood strips without any fastenings.

A Dining Table You'll Be Proud Of

The marble or Corian strip down the middle makes it both elegant and practical

By DARRELL HUFF

A slab of handsome green marble between two slabs of polished wood. That's the top of a distinguished dining table that has three major virtues:

- It's unusually simple to build.
- It's highly functional.
- It's a handsome addition to any dining room.

The three-piece top eliminates any need to edge-glue lumber or put trim around plywood, often the hardest part of building a table. The legs are simple four-by-four lumber columns, bolted on. Much of the assembly is with copper nails. These, their heads sanded flush with the wood, give the effect of metal dowels or heavy pins.

Besides being handsome, the marble provides a place to put hot pots and dishes, right off the stove or out of the oven. When the marble is removed and the legs are unbolted, the table is easy to handle for storing or on moving day.

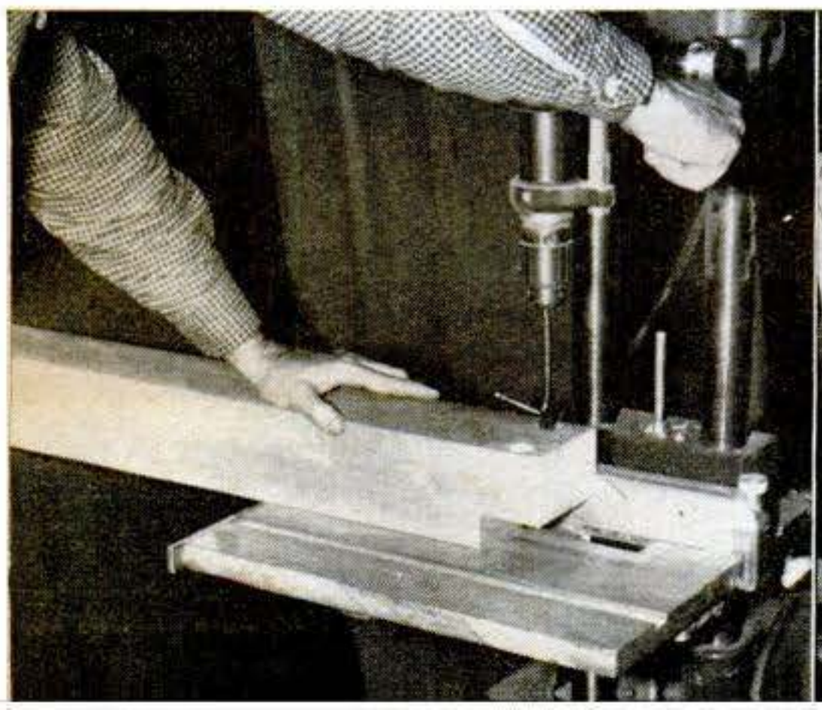
In 76" length, without leaves, the table seats six generously. With drop leaves up you can squeeze in as many as a dozen. For a small family or limited space, a half-length version may be more suitable. I built both versions for members of my family—and know that both have been useful.

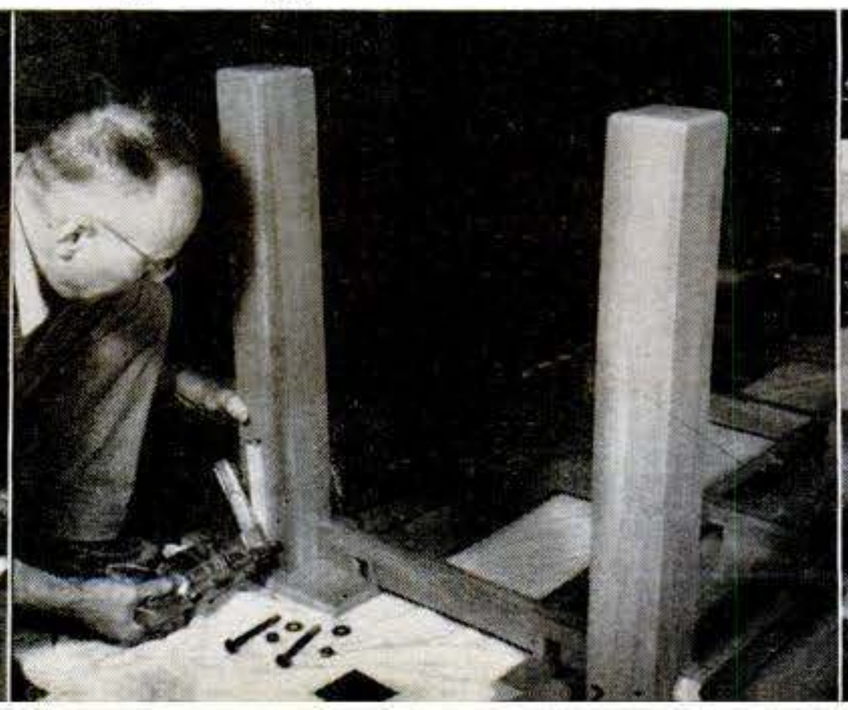
Buy your marble first. Let the size in which you find it most conveniently available determine dimensions of the wood parts. These are easily varied from those I used. The size of my table, for instance, was influenced

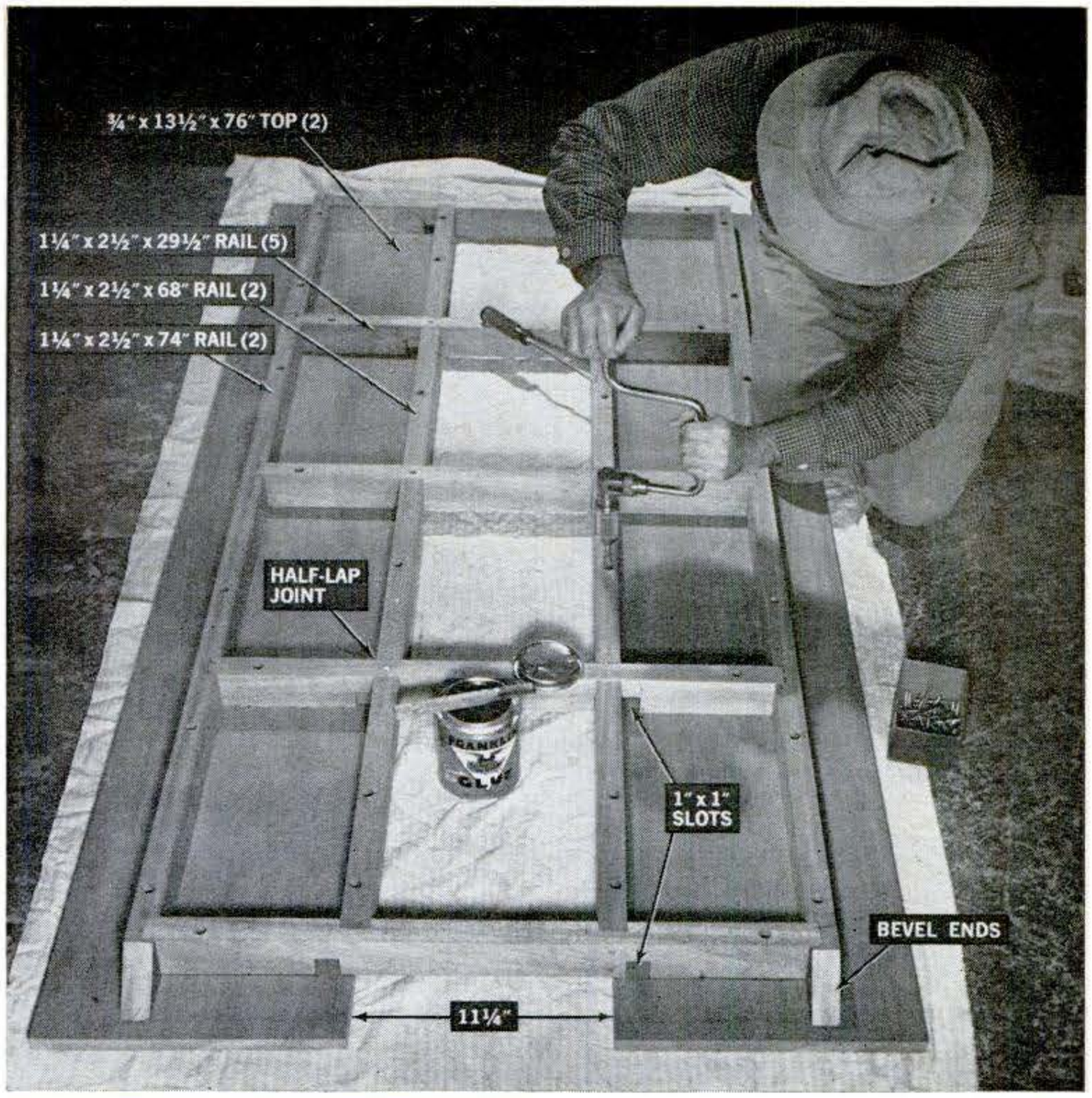
Table legs are 29" lengths of lumber 3¾" by 3¾" square. Cut 1¼"-by-2½" notch at one end and drill to take two ⅜"-by-4" carriage bolts. Counterbore for bolt heads.

Clamp on legs, bore holes through frame. Bolt in place, nuts inside (no glue), so legs can be removed. Note notches in cross rails for drop-leaf support.

Make two U-shaped drop-leaf supports from 1"-by-1" hardwood strips. For each, assemble a 14¾" strip across ends of two strips, each about 34½" long, using copper







Underside view (right) shows construction. Notch and assemble frame with glue and copper nails, fasten to top pieces with glue and screws. Space center rails so marble can rest on them. Counterbore for screws as shown, then plug holes.

by my find of a fine piece of marble measuring 22¾" by 38." Cut in half lengthwise, it made two strips of fine proportions.

Corian is another choice—if you prefer, or if you have any trouble finding real marble. Du Pont's man-made marble, Corian, comes in slabs ¾" thick, up to 30" wide, and 96" long. Buy it from a DuPont dealer; some lumberyards have it. Work it with woodworking tools.

Lumber can be anything that goes well with your marble or Corian. Because it is richly colored, available in wide boards and remarkably inexpensive, I used Philippine mahogany for everything but the legs. Since I couldn't find Philippine in thick enough stock I switched to apitong, a tropical hardwood of similar color and grain.

For finish I rubbed on Danish teak oil. This shows scratches far less than varnish does and is easily renewed when necessary. PS

Materials You Need

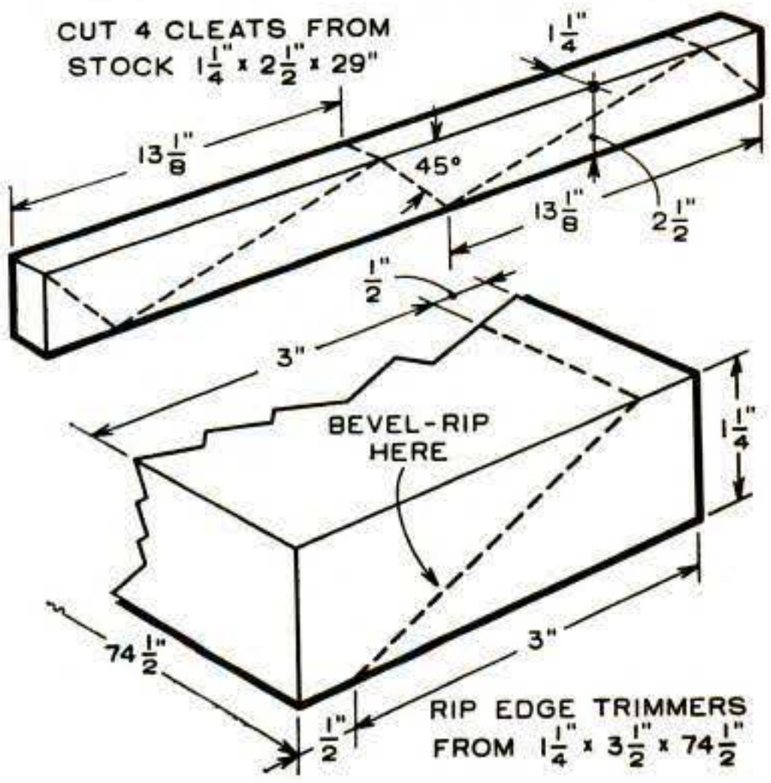
¾" Philippine mahogany to make:
- 2 tops 13½" x 76"
- 2 drop leaves 13½" x 38¼"

1¼" Philippine mahogany to make:
- 2 outside rails 2½" x 74½"
- 2 center rails 2½" x 68"
- 5 cross rails 2½" x 29½"
- 4 cleats (from 2½"-x-29" piece)
- 2 edge trimmers (from 3½" x 74½")

3¾" x 3¾" hardwood (apitong or similar) to make:
- 4 legs 29" long

1" x 1" hardwood (oak) to make:
- 4 pieces 34½" long
- 2 pieces 14¾" long (for drop-leaf supports)

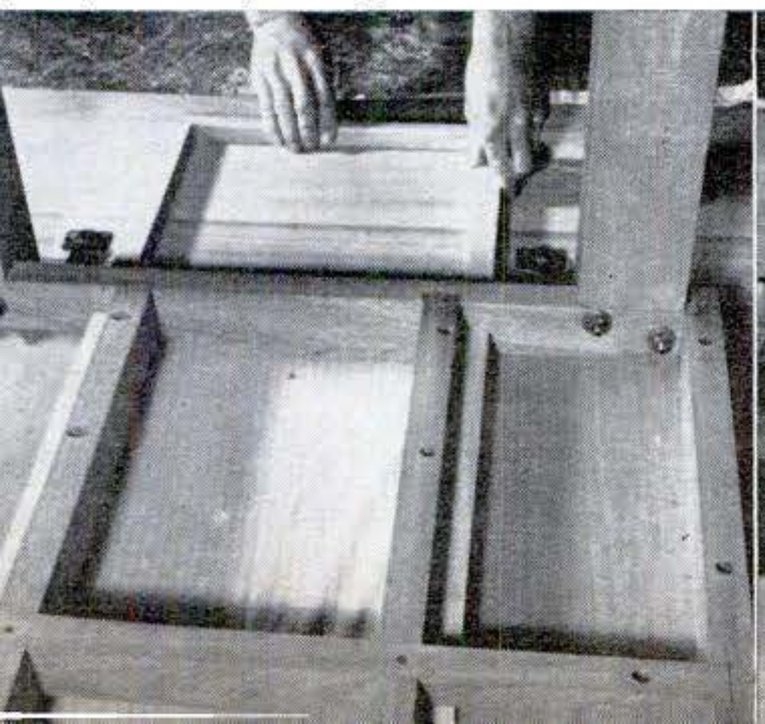
Marble or Corian to suit
2 pr. drop-leaf hinges with screws
34 2½"-12 F.H. wood screws
8 ⅜"-4" carriage bolts
Copper nails 2" to 2½" long
Finish: Danish teak oil

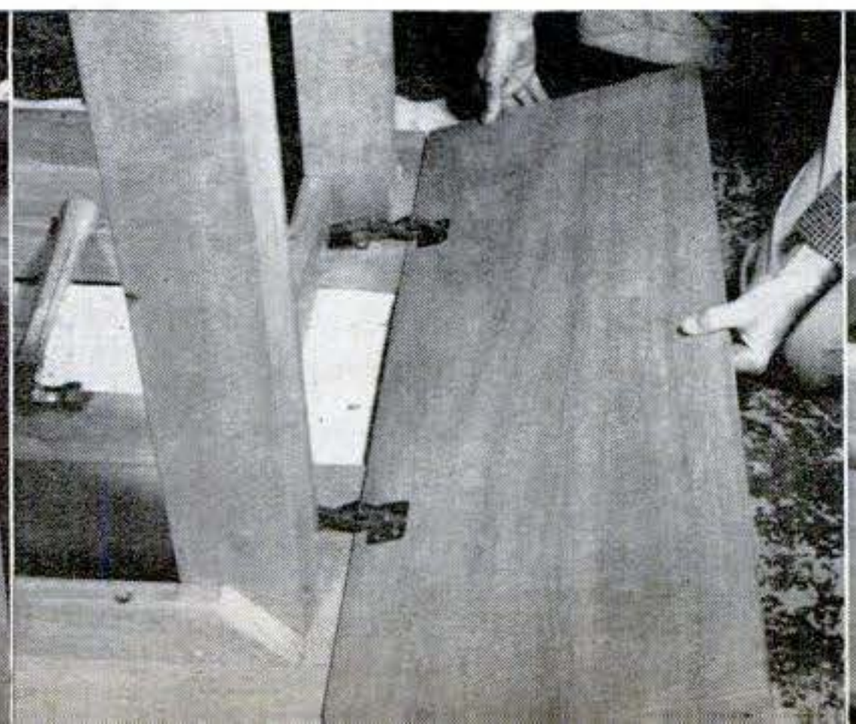


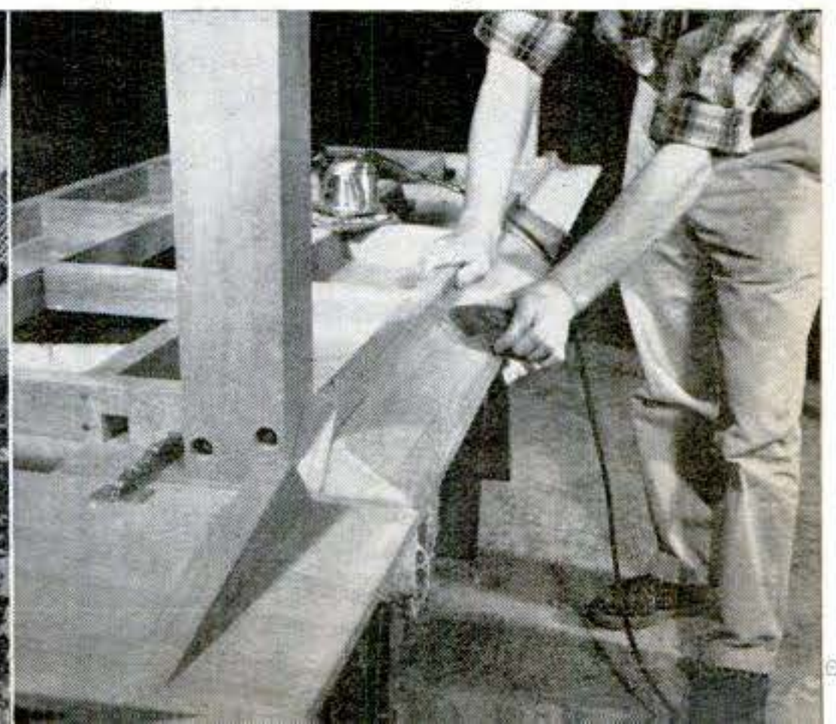
Cut four cleats and two trim pieces from 1¼" stock as in sketches. Bevel-rip trim pieces from stock 3½" wide, 74½" long. Glue two cleats across each leaf to discourage warping, aligning with side rail. Glue edge trim on each side of table. Plane and sand table edge and trim to a continuous taper to look like one piece.

nails and glue. Photo below shows how drop-leaf support fits and works. A snug fit in slots is desirable. Apply wax to the long strips for easy sliding.

Drop leaf for each end is 13½"-by-38¼" piece of same material as top. Ends of hinges shown had to be recessed a bit into frame. Position them with leaf folded.



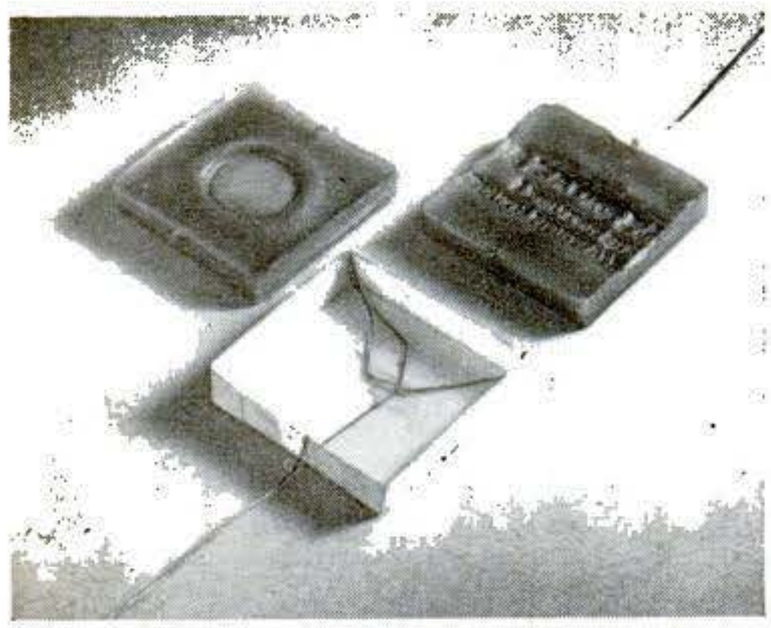




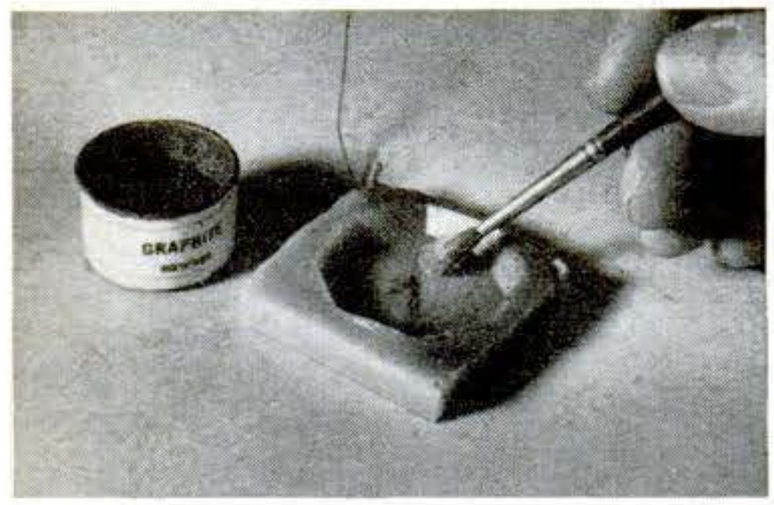
Electroplating

You can put a new shine on metal with a novel plating system that creates its own current

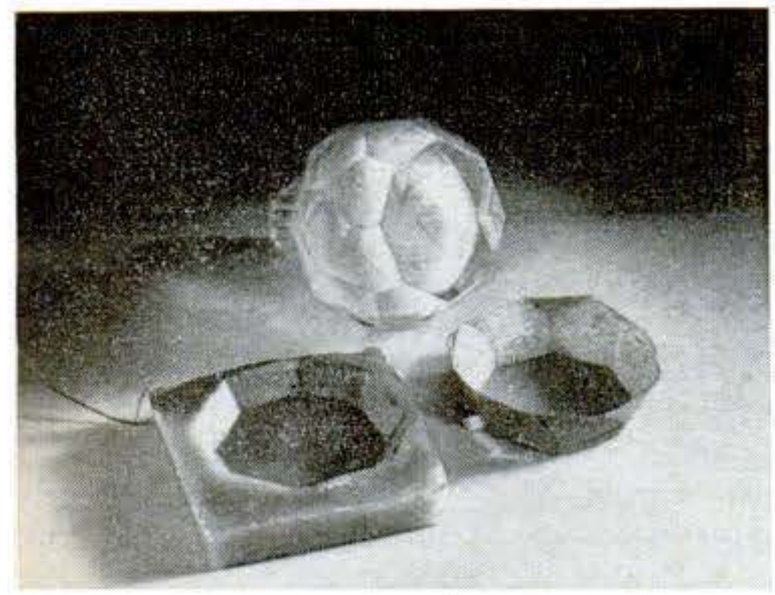
Tiny seahorse was duplicated in copper by electroforming technique outlined below. Duplicate will be trimmed to size.



Electroforming starts with molds like these: wax poured into small cardboard forms fitted with terminals made of copper wire.



Mold is brushed with powdered graphite. Be sure dust covers entire impression and forms a conductive lead to copper wire.



A finished dish, "plated" from nickel, beside its wax mold and the cut-glass saltshaker used as a master for the mold.

Combine a flowerpot, a glass or plastic jar, some common chemicals, and you've got a simplified electroplating system. It works without batteries or other external current and does a fine job of depositing different metals.

Since an electric current always must pass before a metal can be dissociated from its solution and deposited on a desired object, standard plating schemes derive this electricity from dynamos, rectifiers, even batteries. The current we need in our simplified system is self-generated. For this we can thank a scientist named Daniel who discovered the method in 1836—and never dreamed of the twist we're giving it here.

The Daniel cell consisted of an outer jar containing a zinc electrode immersed in zinc sulfate and an inner porous jar in which stood a copper electrode in copper sulfate. That porous jar is our flowerpot.

The pot, preferably new, should be thoroughly cleaned by boiling it at length in water. This gets it to maximum porosity. The hole is plugged with a cork, a rubber stopper, or with a poured layer of paraffin wax.

The size of the pot is immaterial, but will be determined by that of the glass jar you'll place it in. I performed the job in miniature with a three-inch flower pot and a jar cut from a half-gallon glass jug. A cut-off plastic jug works just as well.

Mystery of the depositing metal. You may wonder how a solution of copper sulfate in water, which is a clear liquid without a metallic hint, can deliver pure, solid copper. Or how similar solutions of silver, zinc, nickel, or whatever can be the source of their pure metal. The explanation lies in two phenomena called dissociation and ionization.

You have witnessed the dissociation reaction myriad times in your kitchen—when you poured table salt into water. The salt crystals dissociated into their component sodium and chlorine atoms. The atoms divided between them the formerly neutral electric charge of the crystal lattice and emerged as ions, the sodium positive and the chlorine negative; they became ionized. The metallic salts used in plating act the same.

At this point the well-known principle of "opposite poles attract, identical poles repel" takes charge and we have the "tool" that makes electroplating possible. The object you wish to plate is made negative and thus attracts the positive metal ions. What makes them stick? It will be easier to explain that after we get our apparatus set up and working.

Commercial electroplaters are very persnickety about the percentage makeup of their solutions because thereon hinges profit or loss. For our simple system, keeping the solutions saturated is close enough.

Since the electricity we are generating is actually a chemical energy transformation, it is not surprising to find that the highest currents are yielded by the most reactive chemical combinations. For instance, a zinc electrode in sulfuric acid produces a respectable current at a good voltage; and aluminum in sodium hydroxide (lye) does even better. But there is no need for you to use these corrosive chemicals—in fact, you shouldn't unless you've had some experience in handling them. You'll note from our table that chemicals as innocuous as table salt will see you through to successful plating.

Use the chart to help you decide on the chemicals you want to use. The higher the current flow indicated in the chart, the faster the plating will proceed. Although the chart only gives values for copper plating, the relative plating power of the various chemicals will be the same for other metals.

PLATING POWER OF VARIOUS COMMON CHEMICALS

	SULFURIC ACID	LYE	SALT	AMMONIA	HYPO	ZINC SULFATE	ACETIC ACID	CLOROX
Copper in Copper Sulfate vs. Zinc	1.05V 100ma	1.4V 110ma	1.1V 90ma	1.4V 35ma	1.1V 70ma	1.1V 50ma	1.0V 25ma	0.95V 60ma
Copper in Copper Sulfate vs. Aluminum	0.65V 25ma	1.7V 125ma	0.75V 30ma	1.25V 20ma	0.7V 15ma	0.55V 10ma	0.5V 5ma	0.75V 40ma

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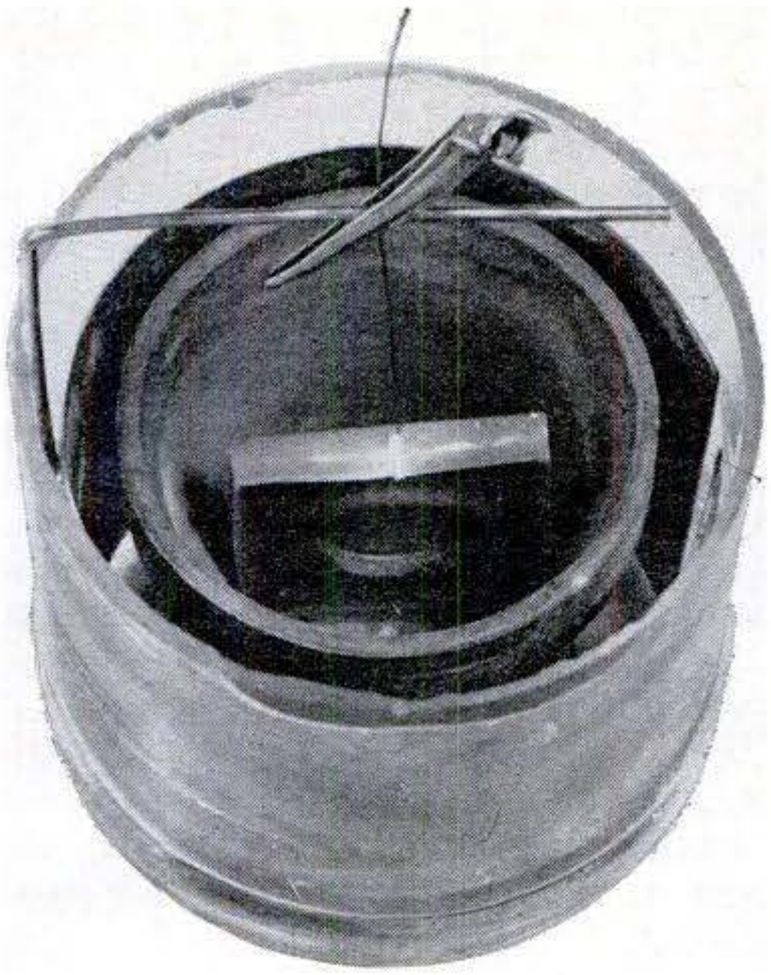
in a Flowerpot

By ERNEST A. ZADIG



The setup ready to go—just pour electrolyte into flowerpot, chemical solution into jar, and plating begins on wax form. Above right: Chemicals for plating are available in experimental quantities from Berg Chemical Co. (441 W. 37th St., New York City 10018). Small bottles of common chemicals are also available in toy stores, sold as replacement items for chemistry sets.

For my own setup I elected to use zinc and lye; the available output of more than 100 milliamperes and almost 1.5 volts promised good plating power. (Aluminum is easier to get than zinc, and gives even more plating power.) The electrode was a sheet of zinc rolled to fit concentrically within the jar with a connection rod soldered to it, gallows fashion, as shown. The rod serves as a bus bar from which to hang the articles to be plated.

For the copper run, the electrolyte inside the flowerpot was a saturated solution of copper sulfate ($CuSO_4$) with a generous "extra" of $CuSO_4$ crystals thrown in. Replenishing the crystals during long operation is important because this is the source of the copper you are plating.

The solution in the flowerpot is made more conductive for our purpose by the addition of a few drops of sulfuric acid. Again, if you are inexperienced in handling this stuff, the same results can be obtained with acetic acid—either the 28-percent kind sold in plastic bottles in photo-supply stores or in the form of vinegar from the pantry shelf.

The solution deposits a very nice plate but you will find the copper coating dull in color. To get a copper plate that's really shiny, we borrow a trick from the pros: Add a bit of table sugar to the flowerpot solution! Why this outlandish addition should shine things up, nobody really knows. But it works!

To electroplate any of the other metals, substitute the corresponding electrolyte. For zinc plating, a saturated solution of zinc sulfate, treated as before. For chromium, chromium sulfate; for silver, silver nitrate; for nickel, nickel in sulfate and nickel chloride; and so on. Adding of ammonium chloride often helps.

And now back to that early question, "why do the impinging metal ions stick to the subject?" (Perhaps you have guessed already.) The positive metal ions are attracted and propelled by the current flow. When they hit the object they pick up an electron (or two or three depending upon their valence). The charge on each ion is neutralized by the negative electron and it becomes an atom, held with millions of others by atomic attraction.

Some gimmicks. The higher the current flow, the larger the deposited crystals and the rougher the plated surface. High temperature of the solutions has the same effect. A further detriment of too much current is an effect the pros call "treeing" and the name is self-descriptive.

Sometimes agitation or removal and replacement of the work improves plating quality; apparently it's the result of the dispelling of hydrogen. This same hydrogen, by its inclusion, is thought to be the factor that makes plated chromium hard enough to act as a new bearing surface for worn shafts and other parts.

What to plate? Any small metal objects are good for starters. But the metal to be plated must be clean—chemically clean, not just household clean. The most effective cleaning techniques are dipping in acid and abrasion with fine sandpaper. Steel wool is not recommended; small steel particles can become imbedded in the work and foul up plating.

Aluminum is hard to plate because it's hard to clean. Oxides form on its surface as quickly as you clean it. If you try plating an aluminum object you'll find nothing will stick to it.

Nonmetallic articles also can be plated but they first must be made conductive. This can be done by brushing them with powdered graphite. This is the process employed in electrotyping, which plays such an important part in printing.

Electroforming, a somewhat similar process, has assumed great importance in the manufacture of intricately shaped parts, ranging in size from minute to huge nickel bulkheads. The desired metal is plated onto a form or mandrel. A small-scale replica of the process is pictured. The sculptured sides of a cut-glass saltshaker are pressed into wax which becomes the mold and is then graphited and plated. The product is a tiny nut dish made of solid nickel.

Electroplating is all around you. The plated metal may be protective or decorative or both. The chromed bumpers on your car, the silver coating on your tableware—all have their genesis in those roving ions. Even your favorite phonograph record took shape under a master pressing plate which owed its existence to electroforming. PS

Small sheets of pure zinc are available from Smith & McCroken, 153 Franklin St., New York 10013.

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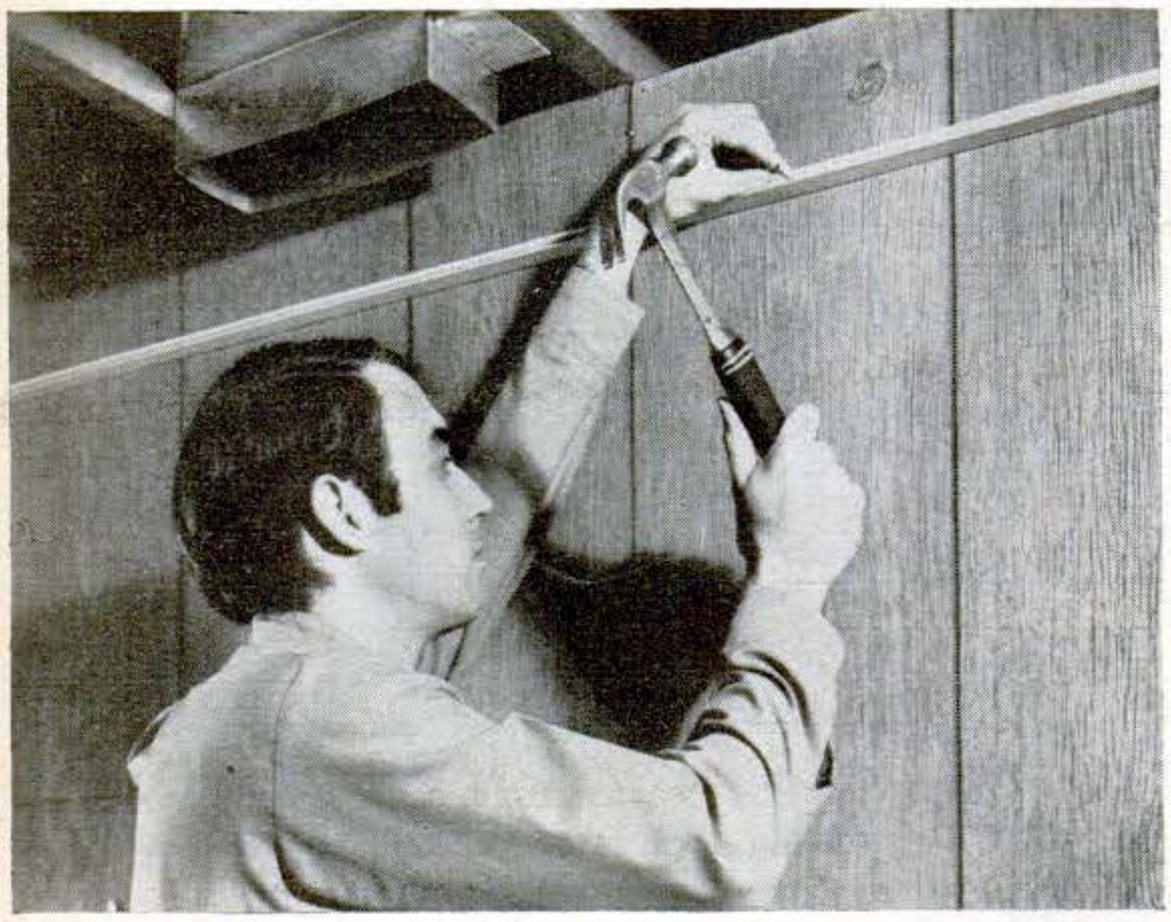
FAST WAY TO QUIET A FAMILY ROOM

Suspend an Acoustical Ceiling



1 **Nail molding to wall** around entire room at height you've decided is best for ceiling, checking with your level as you go.

What used to be called the rumpus room is now usually known as the family room, but the rumpus remains. If you muffle this inevitable noise, you make the room tolerable for several activities at once—and the quickest way to do this is to install a sound-absorbing ceiling. As a bonus, the ceiling inhibits sound spread elsewhere.

According to acoustical experts at Armstrong Cork Co. (whose grid system is shown in these photos) a suspended ceiling of dense wood fiber or mineral fiber will absorb up to 70 percent of the noise striking its surface.

There are additional benefits: A suspended ceiling is an easy way to cover bare overhead joists and exposed pipes or wiring. Since the acoustical panels are laid in the grid *loose,* you have immediate access to those hidden utilities by merely tipping up a panel or two. Also, you can bring down your heating bills by lowering a wastefully high ceiling. The cost of the new ceiling? About $60 for a typical 12-by-15 foot room.

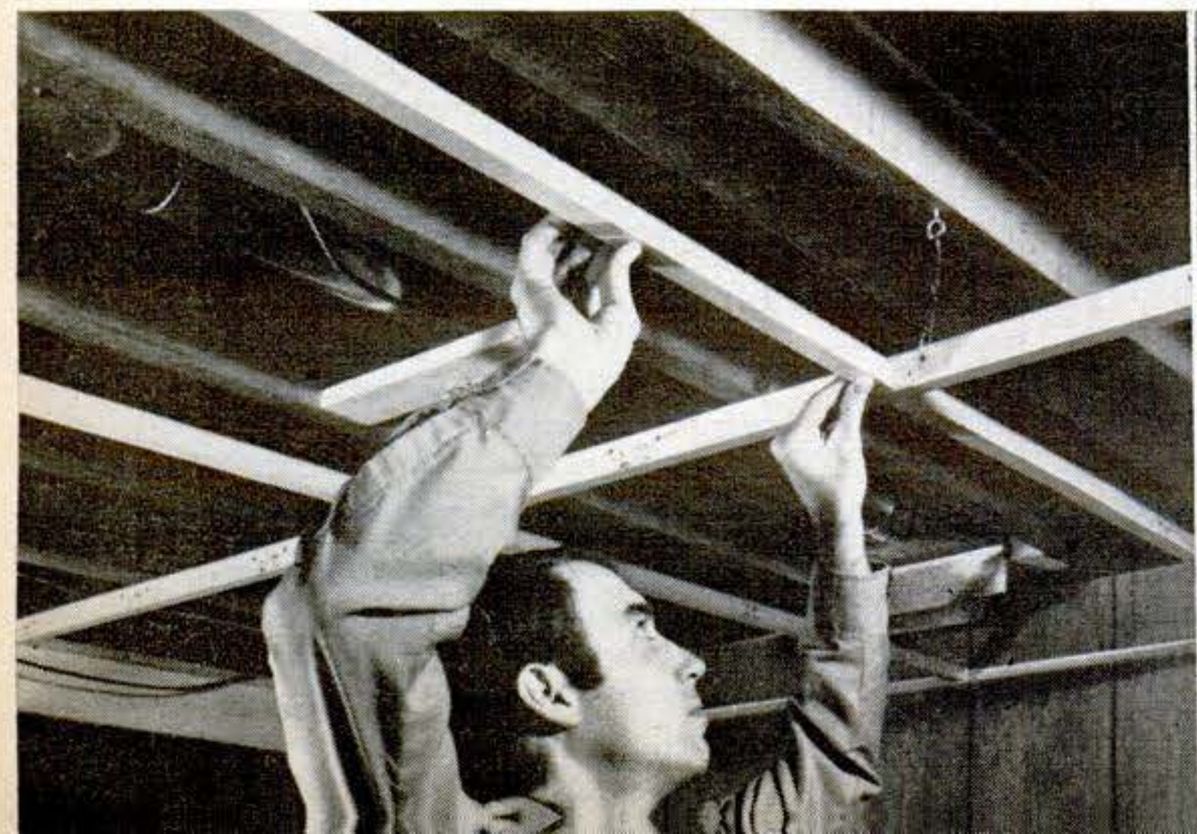
Want to add better lighting at the same time? Install recessed fluorescent fixtures after you've hung the grid, centering them on chosen sections. Then place translucent plastic panels directly under.—*Al Lees*

2 **Attach hanger wires** to overhead joists at four-foot intervals. Stretch cross strings taut to mark height as well as location.

3 **Fasten main runners** of metal framework to these hanger wires, aligning top edge with string to match wall molding.

4 **Snap in cross tees** between main runners, with intersections where hanger wires attach, to complete ceiling-support grid.

5 **Tip in ceiling panels** to rest on bottom flanges of grid. One or two sections could take luminous panels for lighting.



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20 mg. "tar," 1.2 mg. nicotine av. per cigarette, FTC Report Aug. '71.

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E-LITE... A "Man-Overboard" Beacon for Your Entire Family

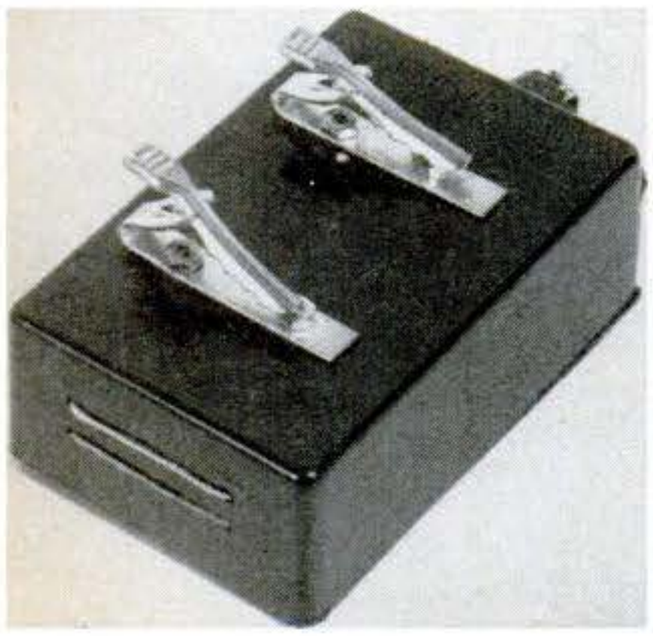
Pinned to your life jacket, E-Lite could prevent a water mishap from becoming a water tragedy

By JAMES G. BUSSE

Falling overboard can be particularly dangerous at night, when it's difficult to see a figure against the black waters. And it's hard to hear the cries for help over the din of the engine.

At sea, for example, the time from when a person first hits the water until the ship can be turned around and still hope to find him among the waves is sometimes less than a minute. Unless someone actually sees him going over the side, a search—particularly one in rough weather—may be futile. Knowing his position could mean the difference between life and death.

Pinned to the life jacket of every member of your crew, E-Lite becomes a beacon at sea the instant it touches water. And, flashing at one-second intervals, E-Lite is visible for more than half a mile and lasts for more than two hours on its own battery supply.



Tie clasps bolted on rear of E-Lite fasten it securely to any life preserver. Water switch is two parallel wires at container bottom.

Here's how E-Lite works. During the day, the relatively large amount of light striking the photocell causes its resistance to drop, so that little voltage is applied to the gate of the silicon controlled rectifier (SCR), keeping it turned off.

At dusk, during the night, and at any other time when little or no light strikes R3, its resistance is high. The resulting increased current flowing through R2 then charges the capacitor, C, to about one volt. This produces a corresponding increased current flow through R1 large enough to trigger the gate of the SCR and light the blinker bulb.

The SCR cannot be triggered, however, and the bulb will remain off, unless current flows across the water switch. So E-Lite cannot be activated unless it is in the dark and its case is wet.

E-Lite's water switch consists of nothing more than a pair of parallel 1" lengths of exposed wire mounted on the lower end of the unit's plastic case. Since the amount of current needed to trigger the SCR is so small, practically any amount of moisture (fresh or salt water) will "close" the switch. For test purposes, a moist finger will do. The water switch is mounted on the bottom of the E-Lite to minimize nuisance triggering.

Light from the blinker bulb also illuminates the photoresistor, R3, thus lowering its resistance. This permits C to charge through both the SCR and R3 to about five volts. The blinker bulb has a small bimetal switch built into it that opens when the lamp heats up and closes to make it blink when the lamp cools.

After the lamp has been on for approximately one second, this internal switch opens, turning off the lamp and the SCR, and thus making R3 dark again. The bimetal switch closes again about half a second later, but the SCR cannot conduct to turn on the lamp. The SCR's gate voltage is about five volts negative instead of one volt positive because of the charge on C.

Completing the cycle. However, current flowing through R2 into C quickly reverses the charge on C, reaching the SCR's triggering voltage of about one volt positive in less than a second. When this happens, the SCR fires and turns on the lamp. This cycle repeats itself as long as the batteries are strong and E-Lite is wet and in the dark.

The electronically controlled blink-

Continued

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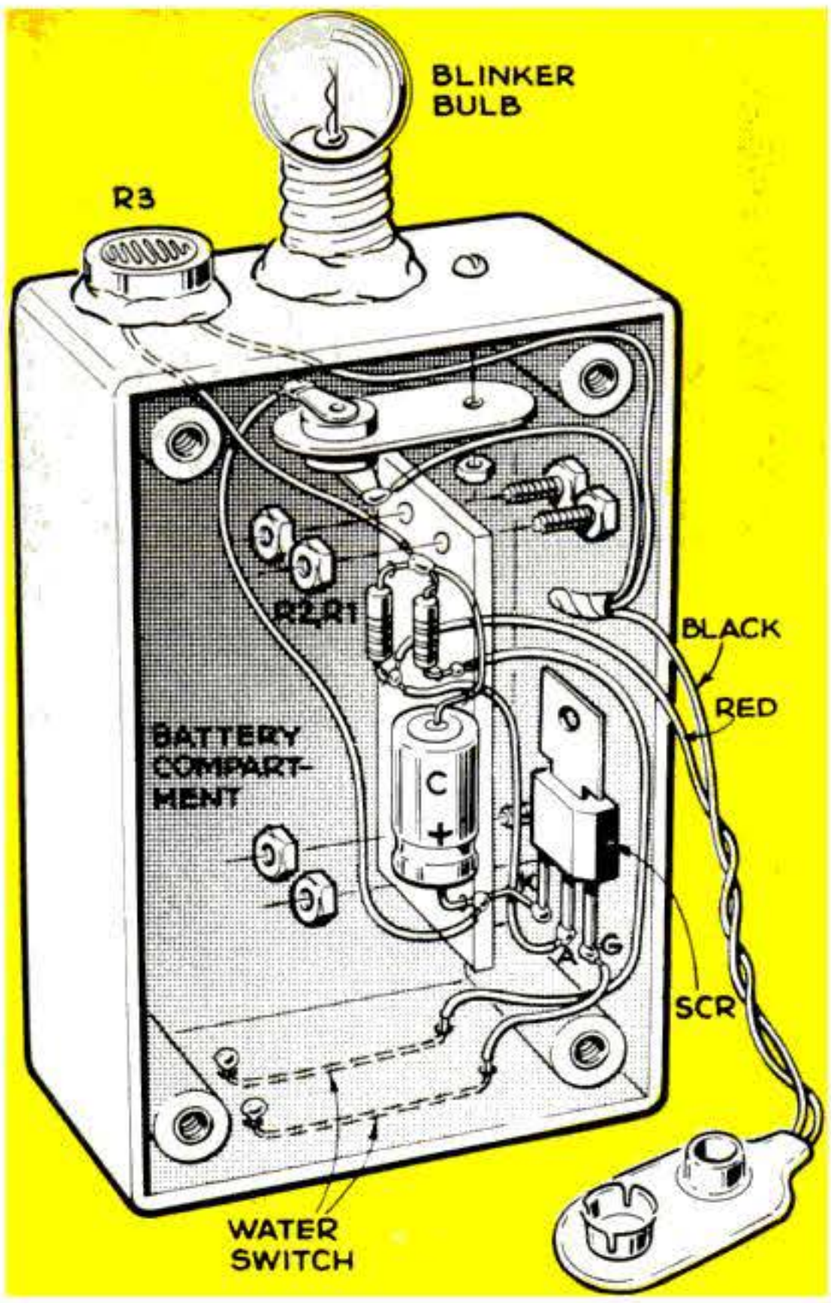
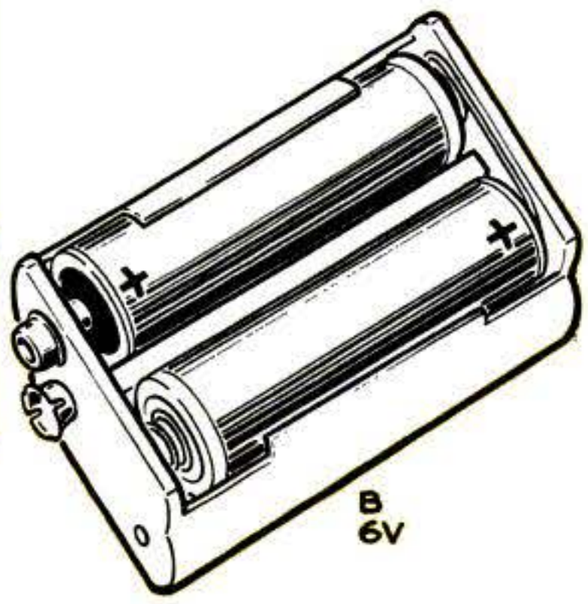


SEAL ALL SEAMS AND OPENINGS WITH SILICON RUBBER AQUARIUM SEALER



PARTS LIST

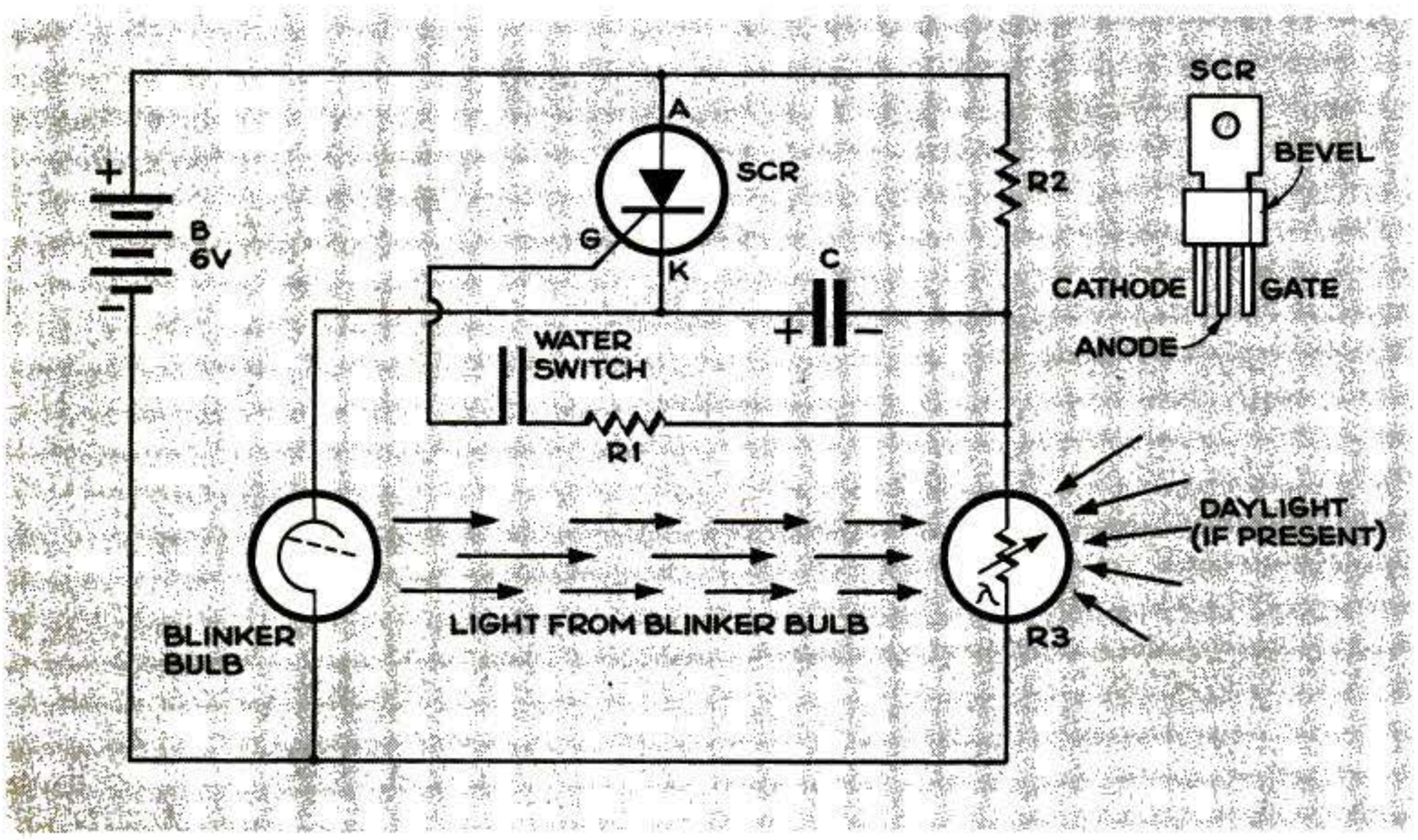
C—25-mfd, 15v electrolytic
R1—2,200-ohm, ½w carbon resistor
R2—47,000-ohm, ½w carbon resistor
R3—Photoresistor (Lafayette 19E21014 or equiv.)
SCR—Silicon controlled rectifier (GE-X5 or equiv.)
LM—Blinker lamp, 6v (GE #407)
B—6v (see text)
Water switch—see text
Misc.—Screw-base bulb socket, battery holder, battery connector, silicone sealant, perfboard, plastic box (see text), two tie clasps.

er bulb flashes at regular one-second-on, one-second-off intervals instead of its usual erratic pattern. This conserves the batteries and provides a signal that can be more easily recognized at greater distances.

Heavy-duty alkaline cells are used to power E-Lite, because of the large blinker bulb's current drain. They should be replaced after use or automatically at three-month intervals to assure efficient energy to keep E-Lite going continuously for two hours after activation.

You can use one six-volt battery or, as shown in the drawing, four AA cells in a battery holder. Larger batteries can be used, but you should consider their weight.

There is no on/off switch in E-Lite's circuitry, so the unit is always "on" and ready to go into action in an emergency. The price for this feature is a small, constant drain on the batteries. Naturally, the amount of drain depends on the amount of light striking the photoresistor, R3. Even in bright sunlight, though, it should not exceed 0.1 milliamp—100 millionths of an amp.



Building E-Lite is relatively simple. The circuit will fit into a 2"-by-3¼"-by-1⅛" plastic box available from most electronic-parts dealers. Mount the components on a small piece of perforated board as shown. The blinker bulb must be mounted in the position shown so that some of its light will strike the sensitive surface of the photoresistor, R3. Otherwise, the lamp will blink erratically.

Use caution when soldering the SCR's leads to prevent damage. Bend the center lead forward to provide more room, and make sure C has the correct polarity in the circuit. Keep the leads short and isolated from each other to prevent future shorts. Remember, someone's life may depend on how well you've put E-Lite together. It must be able to take a drop on the deck and still come back for more punishment.

Make sure it's watertight. The best material to use for this purpose is a black, silicone-rubber sealant (such as Dow Corning Silastic). Use it generously to seal all screw holes and all possible entrances to the inside of the box. Use a substantial watertight gasket around the inside edge of the cover of the box. The unit should be able to continue operating after a good dunking.

Two sturdy tie clasps, bolted (or cemented) to the back of E-Lite, make it easy to clip the unit to the wearer's life jacket. For added protection against loss in the water, a thin safety chain or nylon cord can also be attached to the case and run through a buttonhole.

Test every E-Lite thoroughly. Needless to say, this should be standard procedure before use on a boat. After allowing the silicone-rubber sealer to cure for a full 24 hours at room temperature, submerge E-Lite in a pail of fresh water in a darkened room. The blinker bulb should immediately light and begin flashing at a regular rate. Remove the unit and wipe the water switch with a piece of dry cloth. E-Lite should stop blinking.

If the photoresistor is exposed to external light when the unit is removed from the water, the blinker bulb may continue to flash but in an erratic manner. Simply cover the photoresistor with your thumb for a second or two and the lamp will go out. It's a good idea to test E-Lite every now and then. Just moisten your finger and touch the two wires of the water switch.

Remember, when you begin to build E-Lite, to buy enough components to construct one for each member of your family—including yourself. Make it a required piece of your boating equipment to be worn by everyone on board. PS

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Take one for fast relief from backache and stomach upset.

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The secret is the hull.

The Airslot hull is actually three true vees. With two extra leading edges. Each sponson is itself a small vee, not just an extension of the hull side. This keeps the boat from rolling. And turning on the crest of every wave. And it keeps her stable at any angle to the sea.

The Airslot also has a diagonal slot across each side of the center vee. That gives you two additional leading edges. And that means you get up on plane fast, with no rearing up. And you get exceptional fore and aft stability. And there's almost no pounding. And no pitching. And no spray over the bow.

All in all, the Airslot is a fantastic hull. And we build a great line of boats around it. Everything from 16' outboards to 24' cabin models.

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Our new 165 and 185 Sport Airslots have the same beautiful hull as our standard Airslot line. All fiberglass. LOA is 16'4" for the 165 and 18'7" for the 185. And they give you a little more room where it counts.

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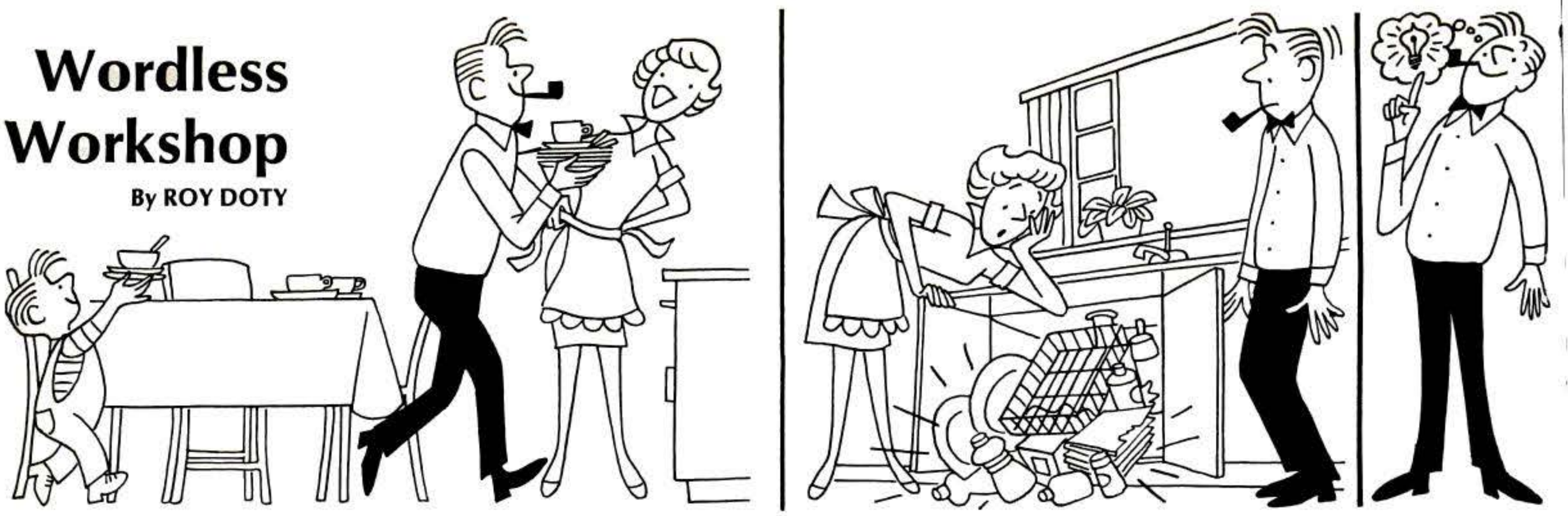
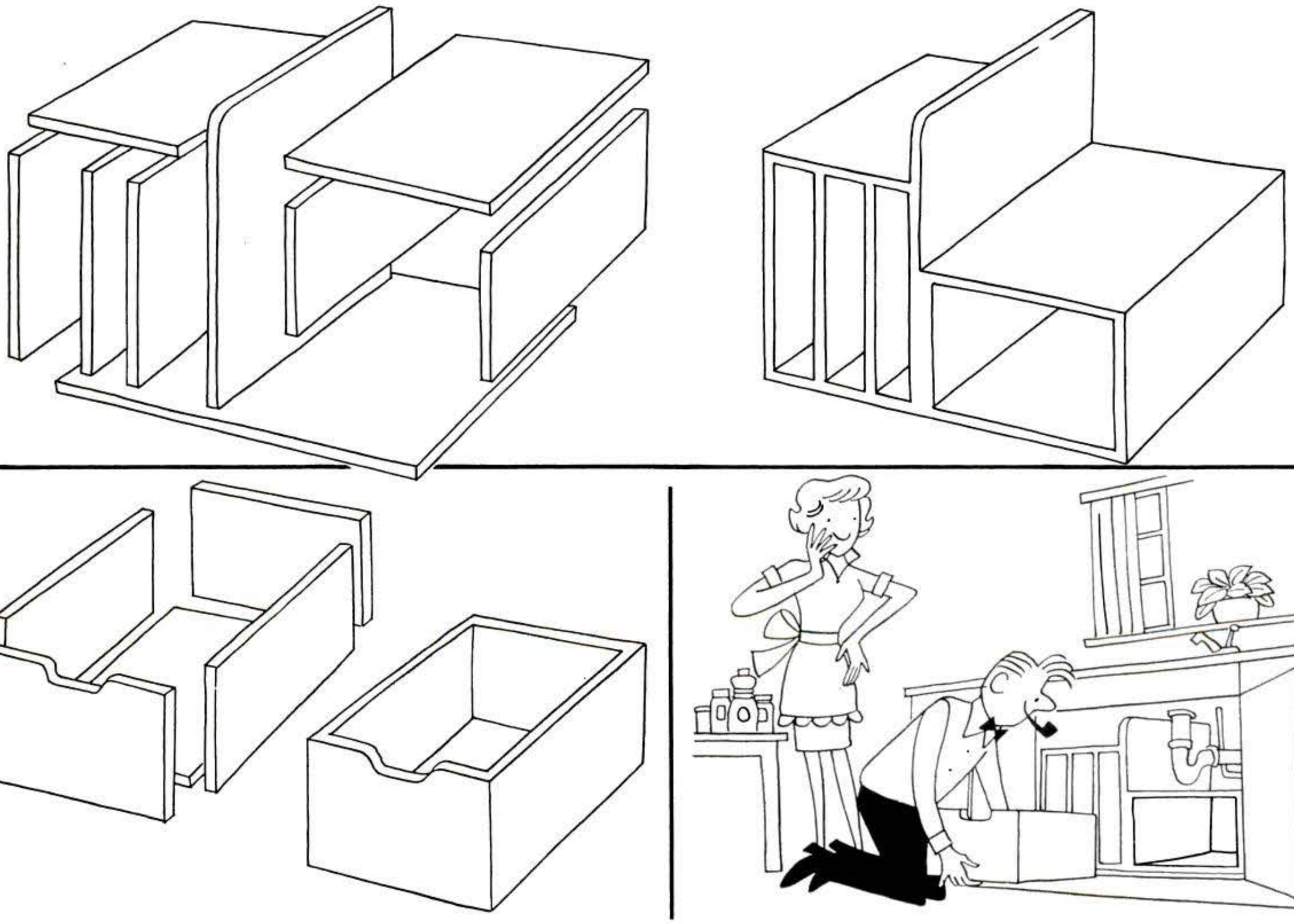
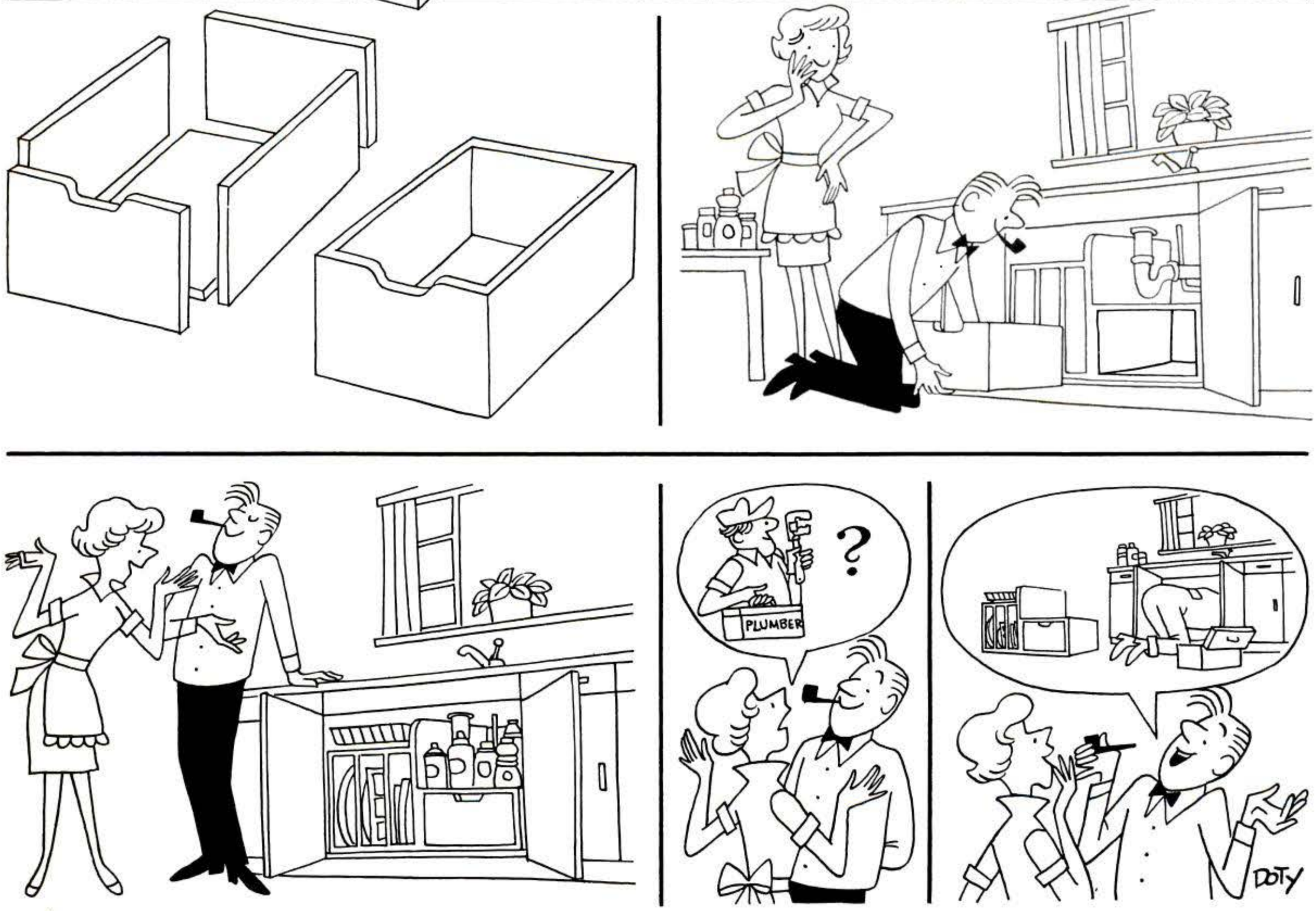
Wordless Workshop

By ROY DOTY







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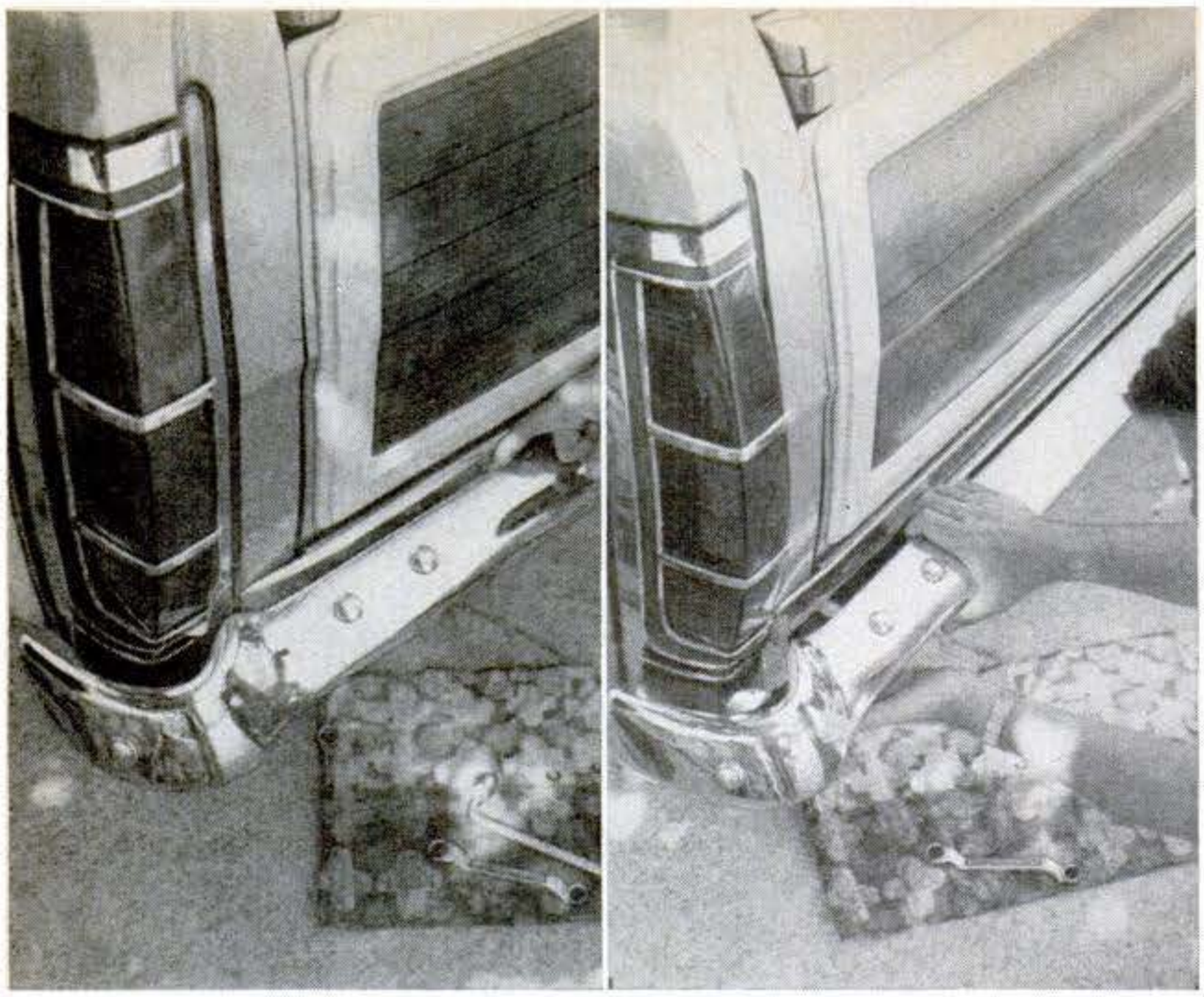


The adjustable bumper is one of the little-known assets on most of Detroit's mass-production cars. The production-line worker sets the bumper's height and projection for maximum beauty. Unfortunately, that position usually gives minimum protection, leaving as little as a quarter inch for the bumper to give before hitting the body or the grille.

Extend Your Bumper for Extra Protection

Extending your bumper won't lower your insurance rates. But it can save you a lot of minor dents and repair bills

By GAYNE EK

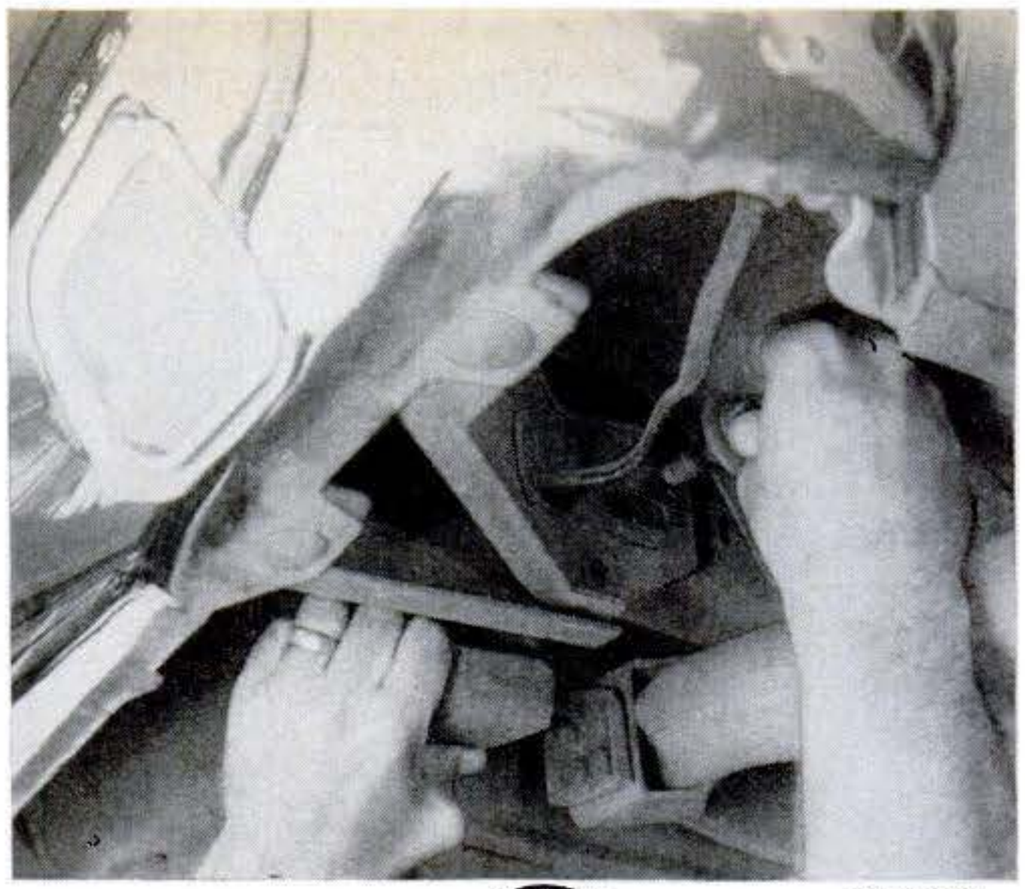
Walk around your car and see how much the bumper sticks out beyond your fender. In some cases the fender will touch a wall before the bumper will. Before I moved my front bumper, it was even with the point of the fender and only 1/8" beyond the center of the grille. Now it gives over 3/4" protection—not enough for five-mph crashes, but enough for parking lots and downtown. In the rear, I could hardly get my finger between the bumper and the frame. Now there's over an inch of clearance.

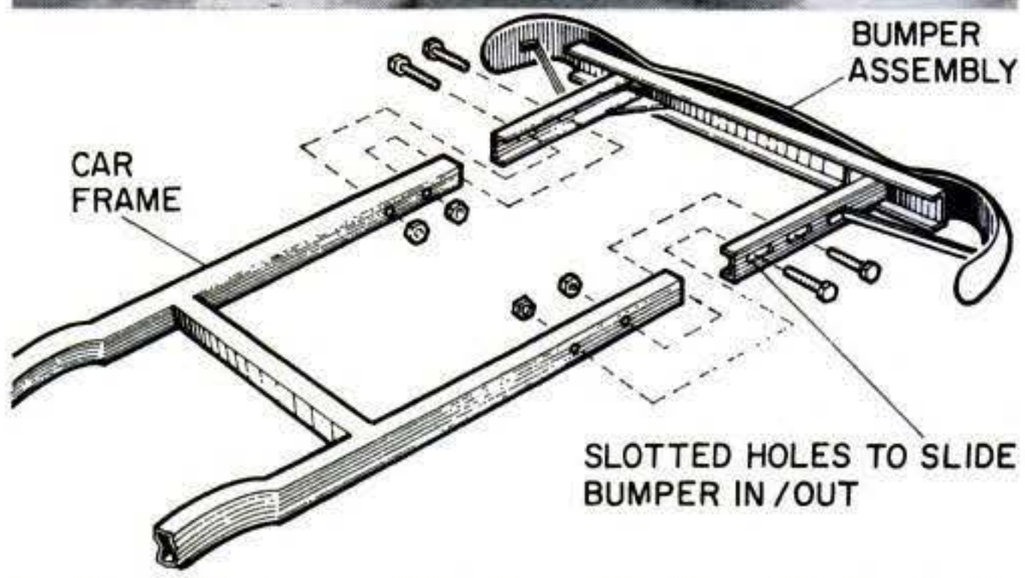
Bumper assemblies today include the chrome wraparound (which you see), and the sturdier sub-bumper (which you don't see, but which provides real protection). These units bolt together to make the assembly that mounts to the frame. On some unitized bodies, bumper extension is impossible. But on most body-and-frame cars, it's a simple task.

How to make the adjustment. Sliding assemblies: Loosen the bolts that hold the assembly to the frame and slide the bumper out. Butt assemblies: Loosen the bolts and insert shims or washers between the assembly and frame. Be sure not to lower the bumper. Measure the height before you loosen the bolts, and again as you tighten them.

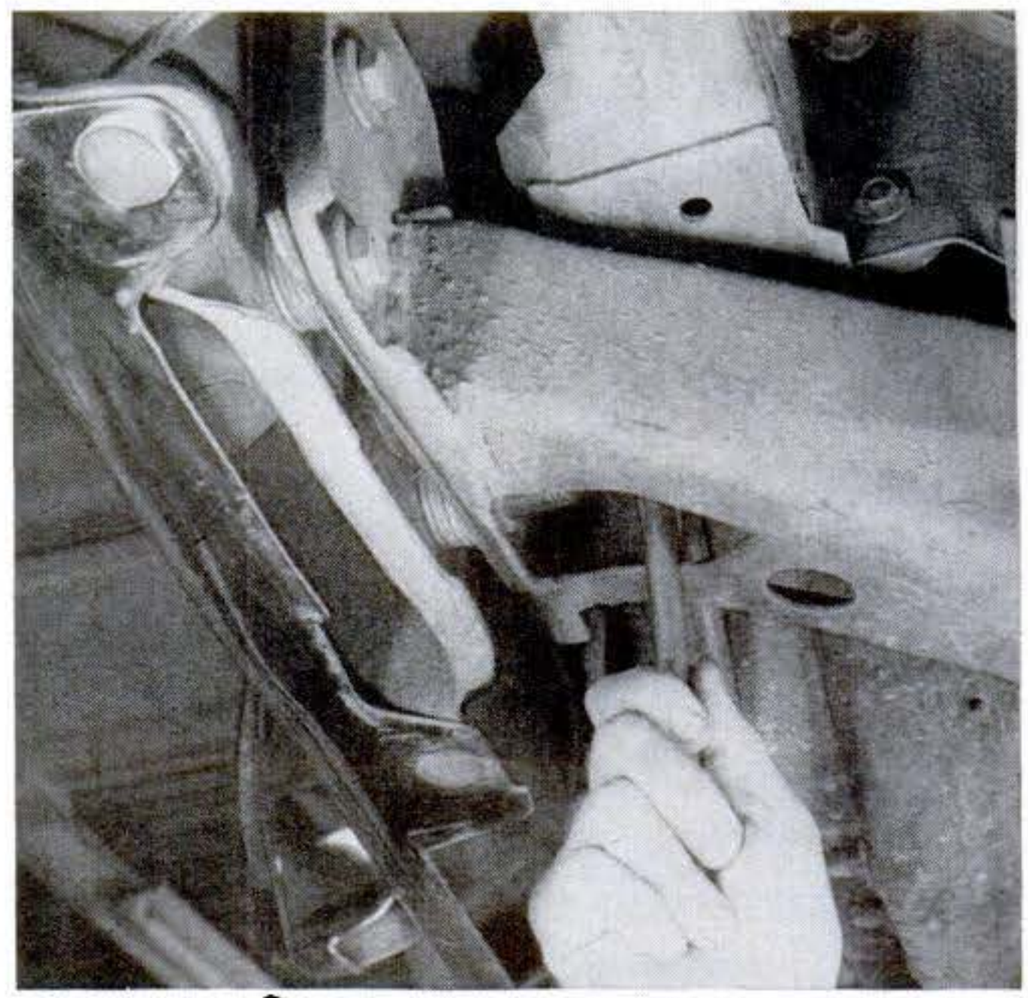
How far out should you move the bumper? An inch is plenty. On sliding assemblies, there's no problem. On butt assemblies, going out much beyond an inch reduces sideways strength.

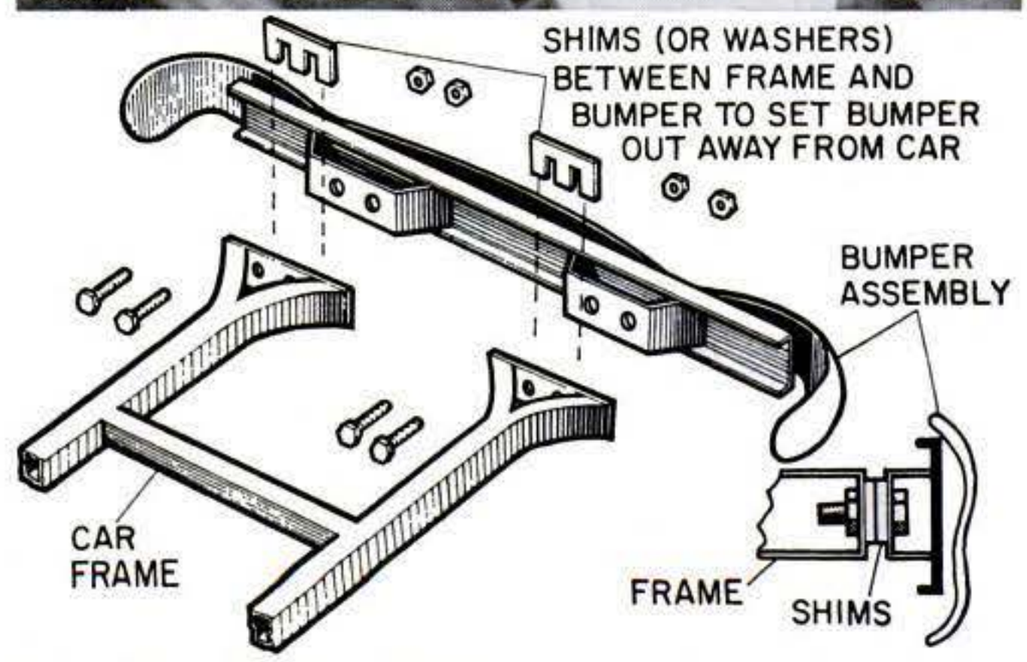
Is extending your bumpers worth the trouble? Yes. Sliding bumpers take five to 10 minutes, butt assemblies 15 to 30. If you care about your car, that's a small price to pay. PS





In this sliding assembly, the adjusting slot is clearly visible with the bolt removed. For adjustment, though, you don't need to remove the bolts. Just loosen them.





Extending a butt assembly requires washers or shims. Washers are readily available, but if you have access to tools and metal stock, shims are easier to install.

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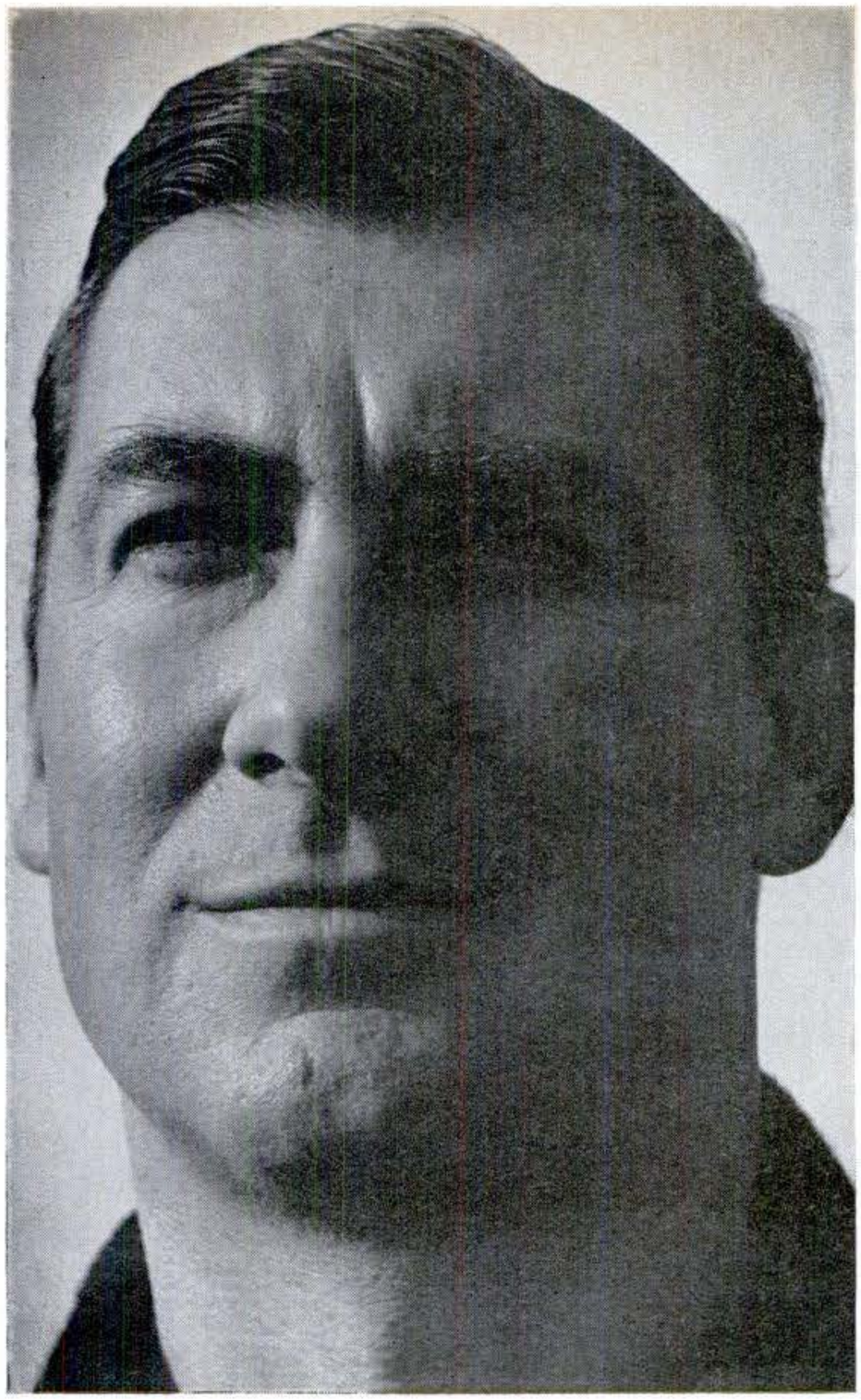

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Taking Care of Your Car

Good hints others have used

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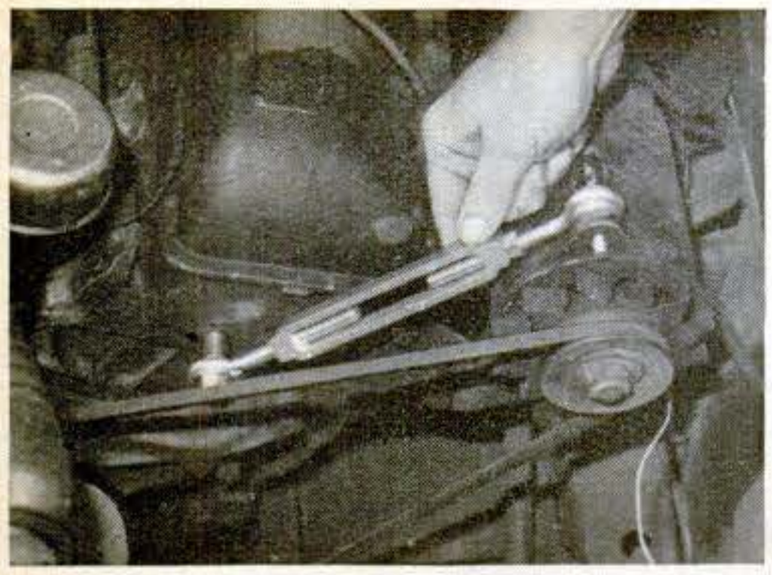
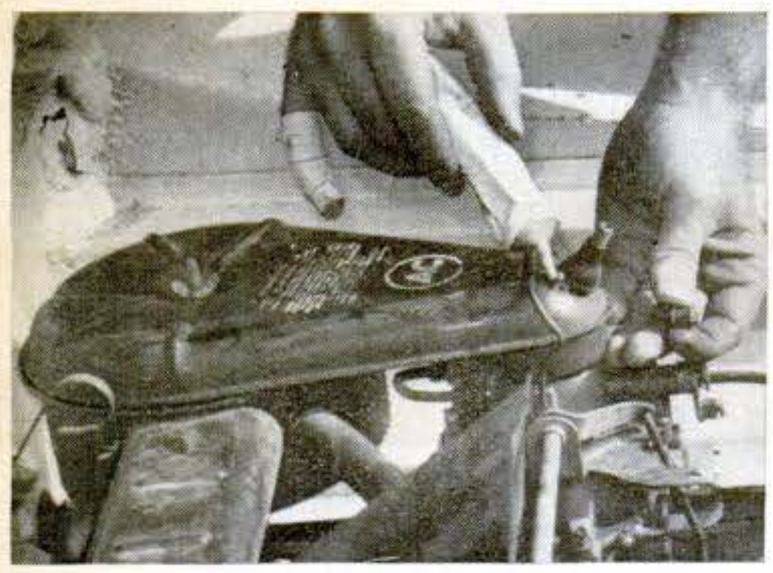
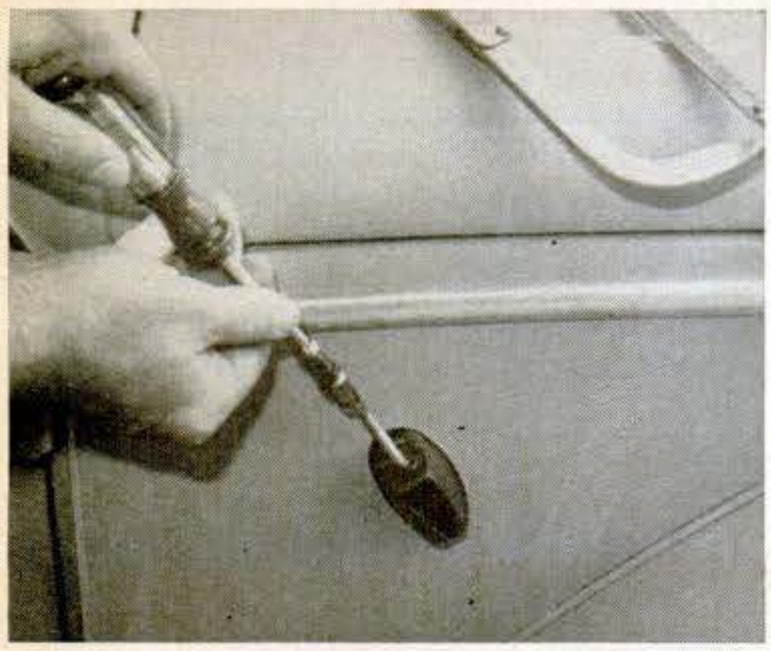


An ordinary turnbuckle is an inexpensive, effective replacement for a broken alternator or generator adjustment arm. A locknut on each end of the turnbuckle will keep it tight. Some installations may require spacers for proper alignment.

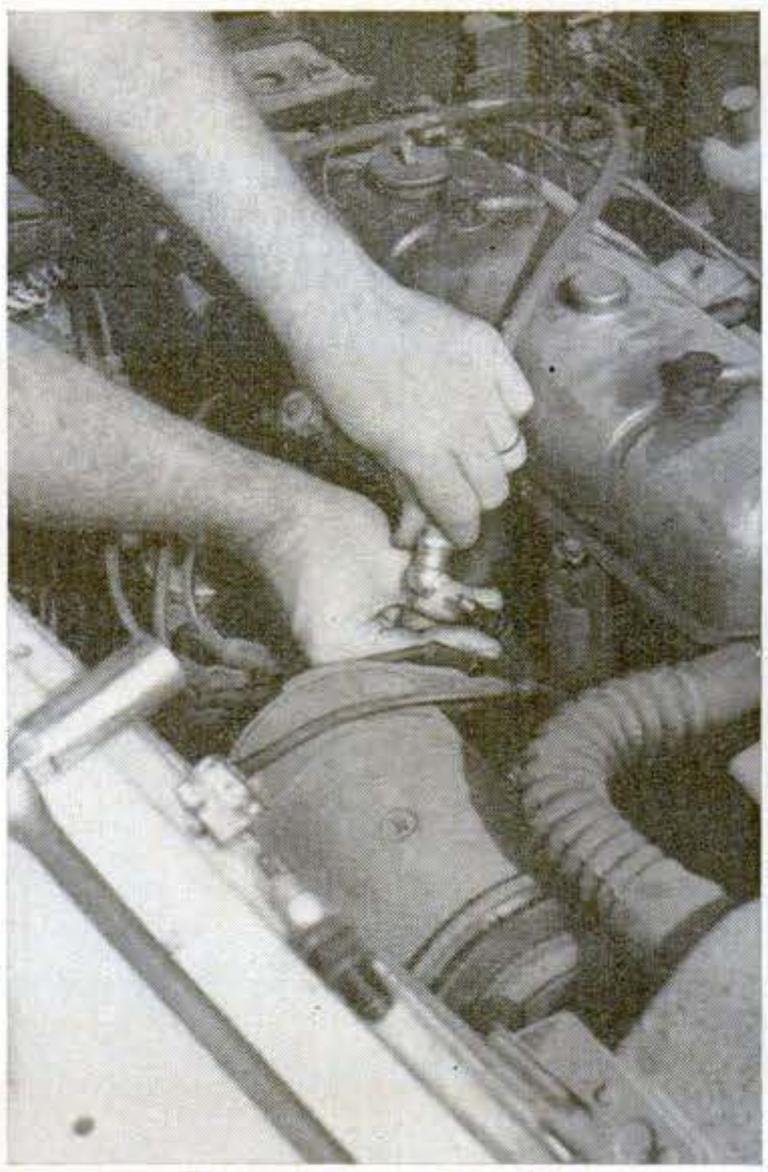
To remove the short stub of a broken axle from its housing: Round up an old broomstick and a 6" length of rubber hose with an inside diameter the same as the axle. Chamfer one end of the hose and attach the other end to the broomstick with a nail. Slide the stick in the housing, pushing the hose over the axle. When it's withdrawn, the axle stub should follow. If the inside diameter of the hose is too small to slip over the axle, a few lengthwise slits of about an inch will solve the problem.



Using starting fluid? Drill a hole in the air-filter housing and install a coreless valve stem. Weatherstrip cement insures a good seal. Inject fluid through the stem, and you won't have to remove the housing. Use a valve cap for closing.



Repair a broken radio antenna with a 2½" #12 wood screw. Trim the base and the antenna tube with a hacksaw. Cut off the screw head and slot the end. Then insert the screw in the base and force the tube over the extended portion of the screw.



Low compression? Place a tubeless-tire stem tightly in the spark-plug hole. With both valves closed, shoot compressed air through the stem. Air leak's location will indicate trouble source. Example: Air forced out through dipstick tube means bad rings.

Rough idling can be caused by an improperly installed carburetor gasket. This six-cylinder gasket is an example. If not installed as marked, choke pull-off diaphragm, economizer jet, and air-cleaner control notches will not align properly.

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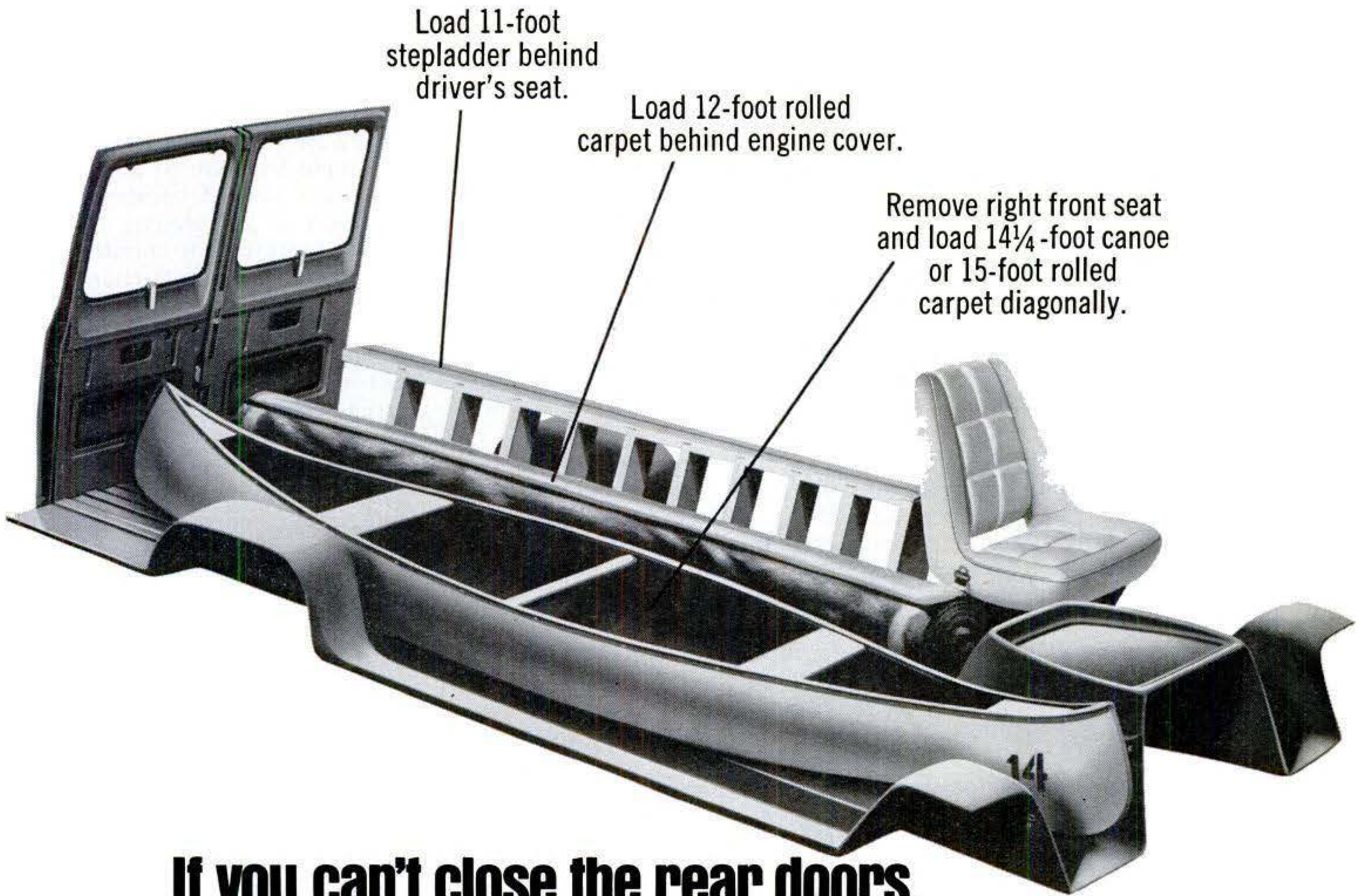
How to tell which is the largest compact van built in America.

(No matter how you look at it.)



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And you'd better get one.

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Sea Knife: A Wild Boat for Wild Water

[Continued from page 99]

supercritical hull—one designed to slice through waves at high speed instead of going up and down on them.

At the time of our PS test, there were only two Sea Knife hulls in existence. One, the 18-foot wooden prototype, was powered by a 140-hp Mercruiser stern drive. The other, an aluminum-and-foam 22-footer, mounted a 188-hp Mercruiser. Later models will be designed with engines up to 325 hp, to go 70 mph or more in rough water.

A first look. I saw the Sea Knife on a cold fall day along the Chesapeake. She was hanging in slings, receiving final adjustments on her just-installed power plant.

Viewed from the side: It looks as if the bow may have hit a rock at high speed and been shoved back several feet. There's a reason for this scooped-out bow line, Peter Payne says. It helps make a knife entry into waves, reduces wetted surface, and reduces lateral forces acting on the bow.

Viewed from the top: It's a dart-shaped boat starting from a blunt nose and flaring back to a very wide stern. The 18-foot prototype contains two cockpit-like seating areas, and an engine compartment. The new 23-foot hull is so new it has no deck covering at all. It is merely a long V-shaped space with a control console about a third of the way back from the bow, room for a couple of passengers in a seat behind the driver, and an open engine compartment.

From the bottom: It's absolutely flat. You've seen "flat-bottomed" boats, but they're seldom exactly that. The Sea Knife is. The bottom surface is itself a smaller version of the top dart-shaped configuration. Built of one-inch-thick fiberglass, it presumably has the strength to take the shock of hard water or floating objects. This flat surface, Payne claims, is where the hydrofoil heritage comes in.

Viewed from forward: Flare is the overriding characteristic. That dart-shaped flat bottom is considerably smaller than the dart-shaped top of the boat; and one single sweeping flare goes from chine to gunwale. This is what gives the boat some of her aircraft-carrier look. And, according to Payne, this is what gives her a good bit of her sea-keeping and water-shedding ability as well.

From the stern: The stern drive is partly concealed by a "bustle." Extending from the top of the gunwale down to within six inches or so of the waterline, this appendage is filled with foam and—according to Payne—helps give stability both at rest and in sharp turns. It also gives the boat a bit of a tunnel-hull look, which is entirely misleading.

A single trim tab to port combats torque. It's needed because the narrow beam of the planing bottom is insufficient in itself to counteract propeller torque. In production models of the Sea Knife, the cooling-water intake system will be integrated with the trim tab, which will have a perforated undersurface to feed cooling water through a single hose to the inboard engine.

Testing the theory. An oddly attractive piece of machinery, the Sea Knife both excites the imagination and raises questions. One way to check on both the promise and the potential problems is to drop her into the water and try her out. At the risk of chilblains, we did just that.

Afloat, it's one of those craft that look fast even when sitting still. However, it has one slight problem at

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rest. It tilts. Any slight shifting of weight away from the centerline quickly sends the corresponding gunwale down. The center of gravity shifts to the chine, which makes a sort of keel. Very unusual.

The same effect is present when you idle the boat in reverse with the power unit in position for a starboard turn. The gunwale on the starboard side promptly goes down to the surface, and the first few times you try it, it gives you the uneasy feeling you are going to flip over like an Eskimo in his kayak.

Underway, the boat quickly demonstrates stability. She presents a very bow-high attitude in the early stages of acceleration, but settles down to a comfortable planing angle.

At greater speeds she lands on plane with a solid "thunk" onto her flat bottom. A very different feeling from either a deep-V or cathedral hull. It's like riding a high-powered shingle across the water, with very little actual displacement. But trimming the prop downward in rough water makes the small flat bottom act as a fully submerged hydrofoil.

In the flat planing posture, we made sharp turns with no difficulty. The right-angle chines dug in and helped give good directional stability. However, I had another maneuver I wanted to try. When the boat was still on the slings I had asked: "With the completely flat bottom and sharp chines, why doesn't the Sea Knife slip sideways in a turn, then trip itself?"

I was told this had never happened. So, to test it, I got the boat up to full speed in the flat planing position. Then I began a gentle 180-degree turn to port. Not sharp enough to cause the chine to dig.

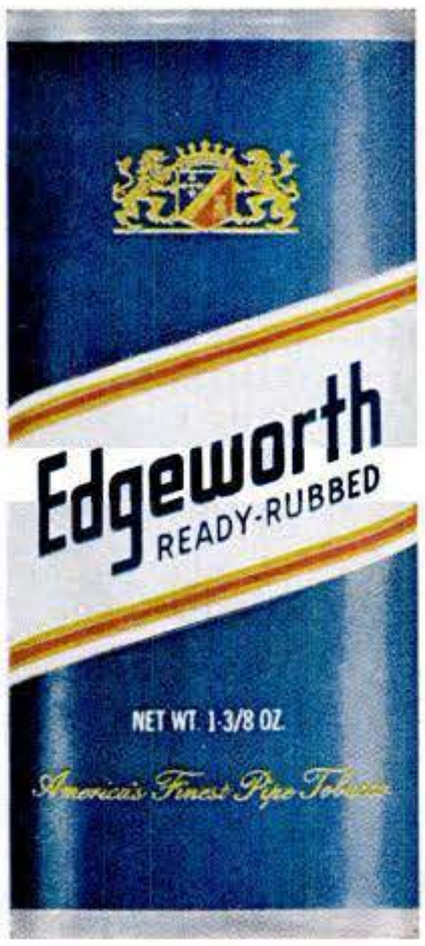
Instantly, it happened. In a fraction of a second we had slipped, tripped, and were thrown violently against the starboard side.

Payne, who was riding in the back seat, thinks one solution would be to move the driver's position forward, or otherwise provide more ballast forward so that the knife-like bow would be in contact with the water to help provide a keel action in such a turn. Actually, the wooden prototype that has been subjected to most of the water tests has the driver's station several feet farther forward.

This was the only really bad habit the Sea Knife showed us. We had no high winds, and so had to satisfy ourselves with only the rough water of our own wakes and that of our 36-foot photo boat. In all other maneuvers, both across the wake and diagonaling within the wake, the Sea Knife tracked very well at almost any angle. We tried drag-strip starts, rapid accelerations close to the stern of the photo boat, and long high-speed runs. She handled well. A look at how the Sea Knife is built backs up Peter Payne's claim of her aircraft-designed heritage.

Built as a boat within a boat, the Sea Knife's watertight inner structure has bow, sides, and bottom shaped like the finished boat. This is mounted within the exterior hull, and the space between is filled with foam, hermetically sealed. The center of buoyancy is high in the flared sides, so that even if swamped the boat will not capsize—and if it should flip, it will right itself.

Perhaps not yet the perfect boat—which seems to be what that big black-and-blue spot on my shoulder is telling me. But definitely a design full of promise. The Sea Knife is a new slice of marine technology. Better keep your eye on her. PS



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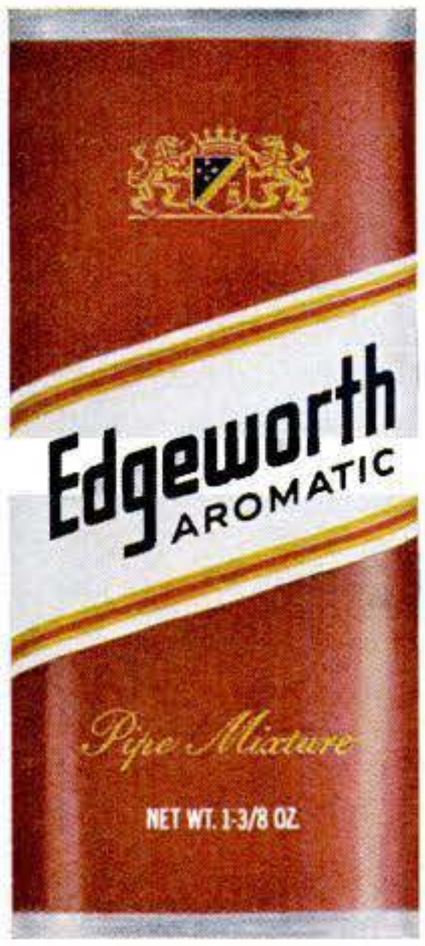

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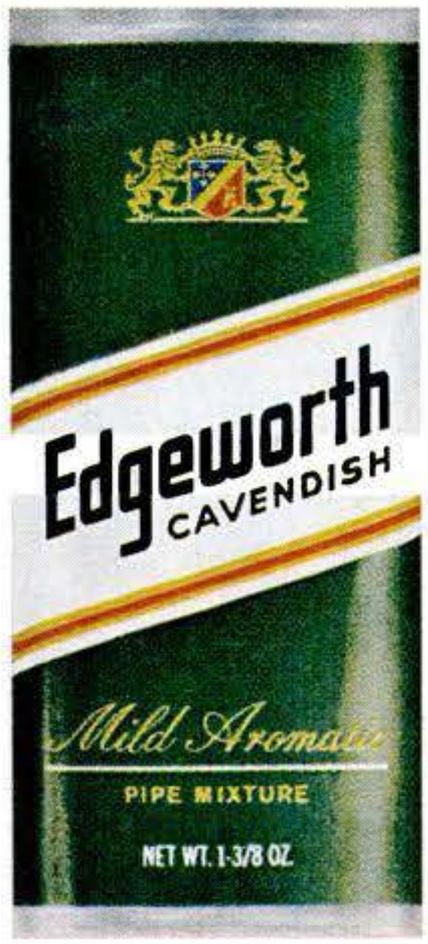

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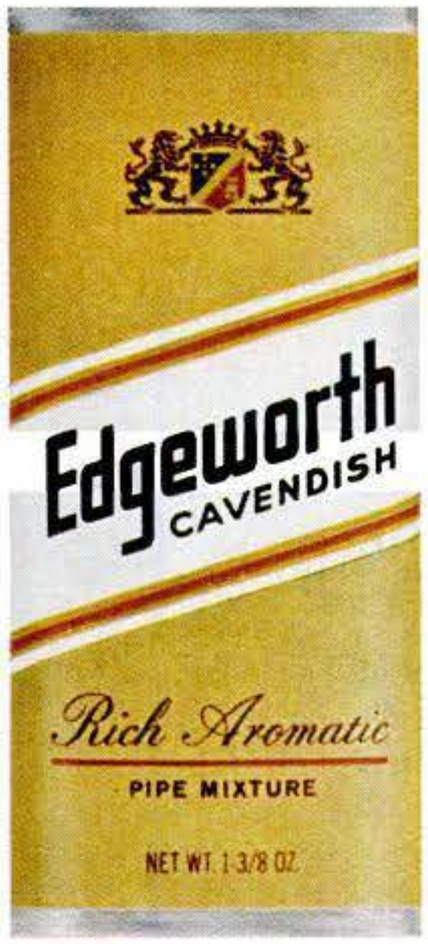

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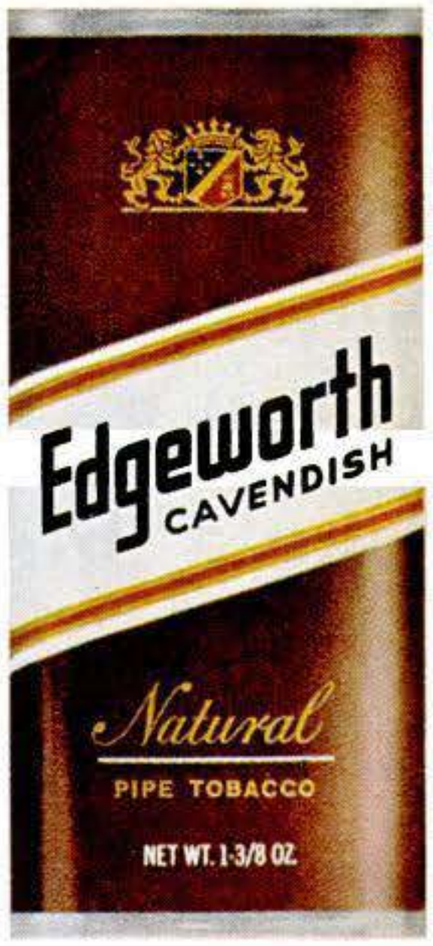

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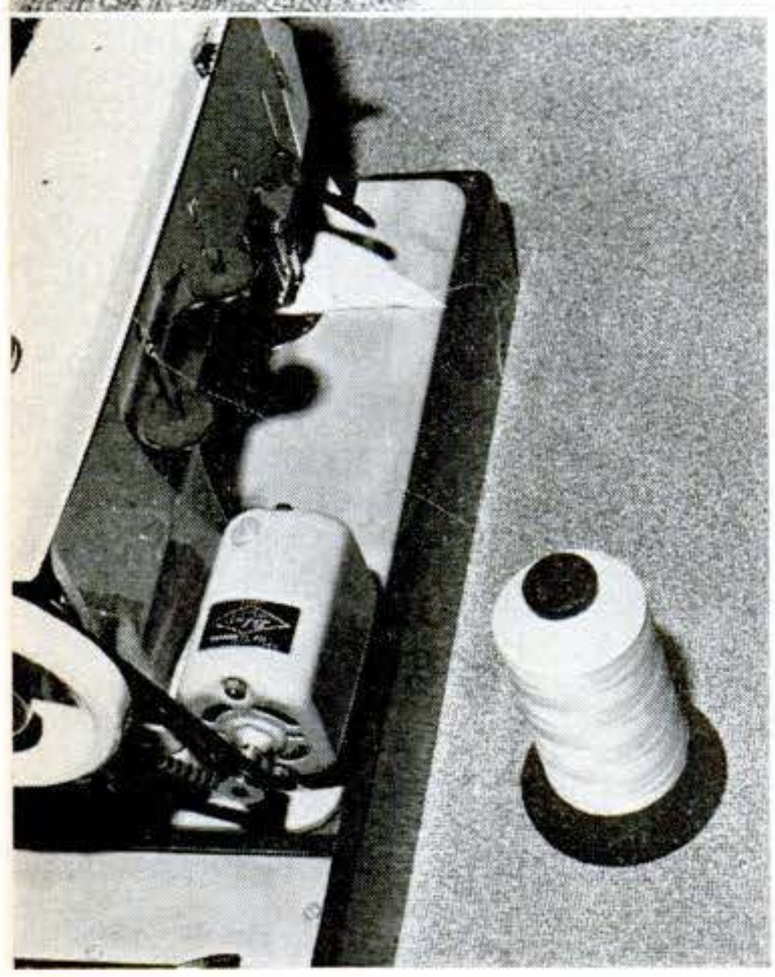


Sew Small-Boat Sails Like a Pro

To sew a straight, puckerless seam in nylon or dacron sails, file or grind the tip of a small soldering iron (the kind used in electronics work) to a needle point. After the sail edges have been overlapped, tack them together by touching the heated tip lightly to the material as in the top photo. Space tacks evenly between the tines of a fork. Put plywood or other insulation under the material to avoid marring the work surface. Finish the seam on a sewing machine.

To use a large spool of sailmaker's dacron or nylon thread on a home sewing machine, drill a #50 hole in the top of the thread spindle, perpendicular to the shaft. Set the spool behind the machine and pass the thread through the #50 hole before threading normally.—*C. Skladal*

SHOP TALK

By ROBERT P. STEVENSON

How do you mount the iron in a block plane?

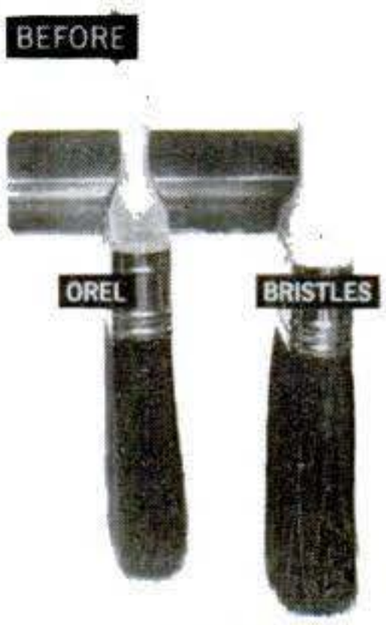
The question came up some time ago as to which way you should mount a block-plane iron—with the bevel up or down? Even though convinced I knew the correct answer, I decided to submit the question to an expert at Stanley Tools. The answer:

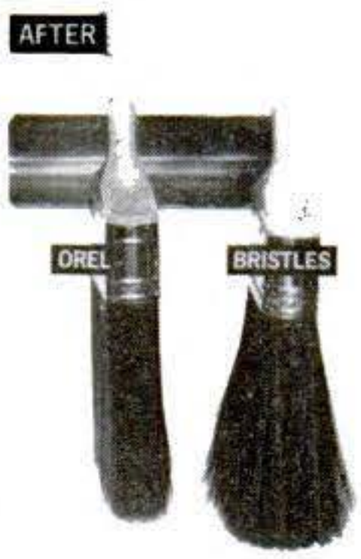
"In a regular bench plane, the iron is placed at quite a steep angle and the wood impinges against the front side of the iron, with the beveled side being back of the edge and never touching the wood chips.

"A block plane is usually made as a so-called low-angle plane merely to fit the hand better. In this case, the plane iron is turned upside down so that the bevel edge cuts against the wood. The actual cutting angle of the wood against the face of the plane iron is very nearly the same on both a bench plane and a block plane."

So mount the iron bevel-side-up in a block plane, bevel-side-down in others. A block plane, used mostly for end-grain planing, gets its name from this function—once commonly termed "blocking in."

New brush better than hog bristles for water paints





Chances are that most of the painting around your home from now on will involve water-based paints. So you'll be interested in news about an improved brush for applying them. The news concerns quality brushes made of Orel tapered polyester filament, now available where Du Pont products are sold. Du Pont scientists developed this filament specifically for paintbrushes. The scientists have just let me know about a test they made to compare how the Orel brushes would stand up in comparison with good-quality Chinese hog bristles when used for water paints on a hot summer day. The photos tell the test story. The two brushes were subjected to a four-hour exposure to 100 deg. F and 100-percent humidity in the test chamber. The Orel brush showed little change. The other brush lost its shape. So Orel should be best for water paints.

Install your own central vacuum system

Central vacuum systems for homes are offered now by several manufacturers. One company has just sent word that it also has a free booklet on how to make the installation yourself. Write to Colt Industries Small Pump Operation, 3601 Kansas Ave., Kansas City, Kans. 66110.

Fire-retardant wood for home building?

Wood shingles and other wood products used in home construction can be made fire-retardant by treating with chemicals. Technologists at the U.S. Forest Products Lab in Madison, Wis., recently subjected 33 chemicals to intensive tests and wound up rating four as highly promising for long-term wood protection. The tests were carried out on western-red-cedar shingles and shakes, but the investigators concluded that the results would apply equally to other forms of wood. In addition to subjecting the shingle setups to a series of fire tests, the investigators sprayed them with water and exposed them to sunlamps periodically to simulate weathering conditions. The simulated rainfall washed away much of the chemical formulations. Shingles that had been pressure-treated stood up best. Of wood shingles now sold, only a few have been given a fire-retarding treatment.

Model-plane builders use silicone rubber

Dow Corning sends word that model-plane builders are making good use of its silicone-rubber sealer. The goo, available in many stores, serves both as an adhesive, where a flexible joint is desired, and for sealing fuel tanks and control-cable openings in the engine compartment. Flexible joints withstand vibrations without breaking. The material also can be used to mold scale tires and other rubber parts.

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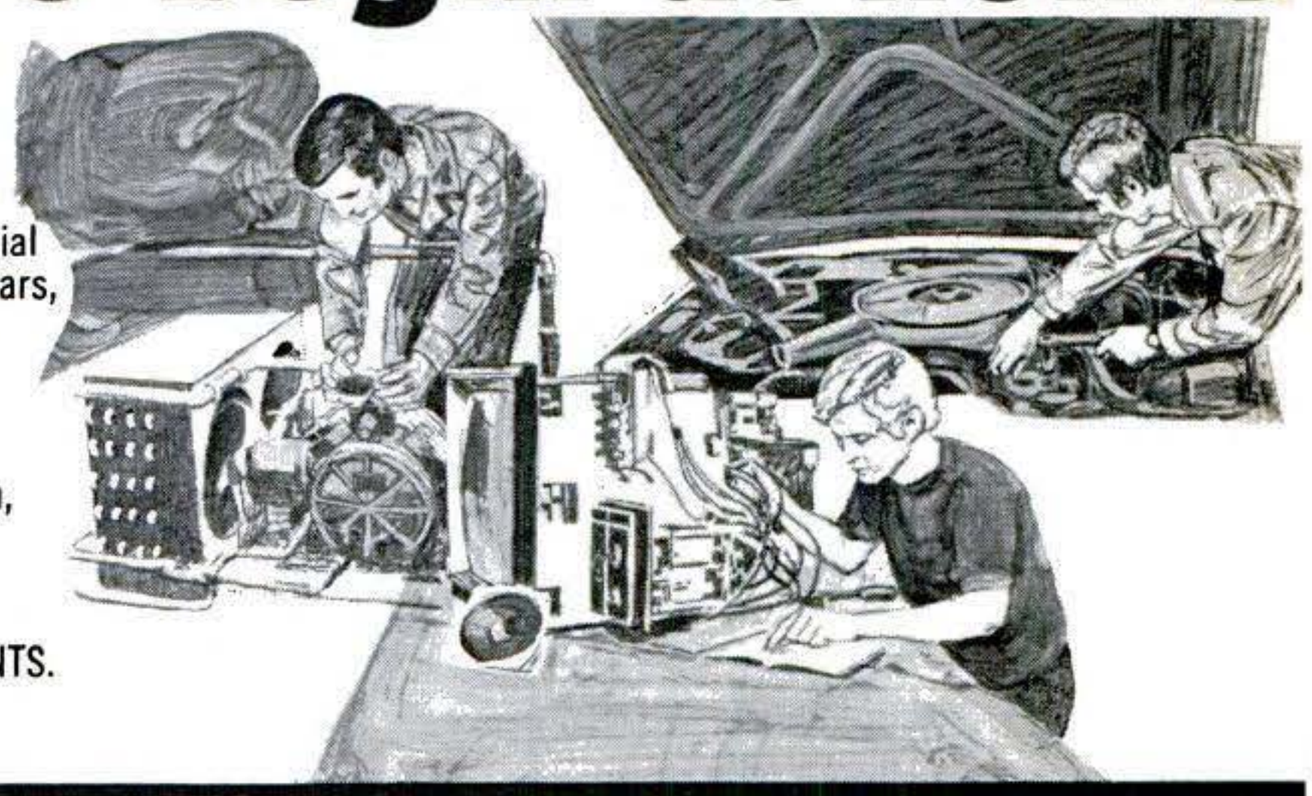

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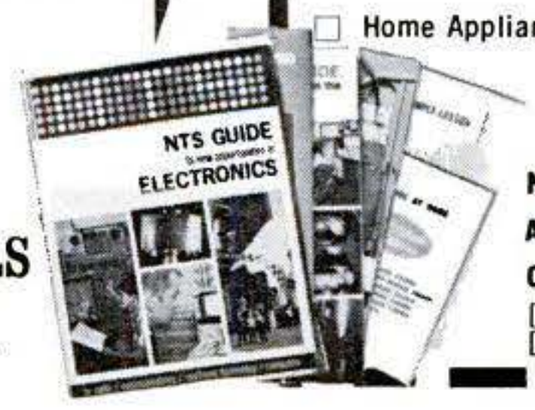

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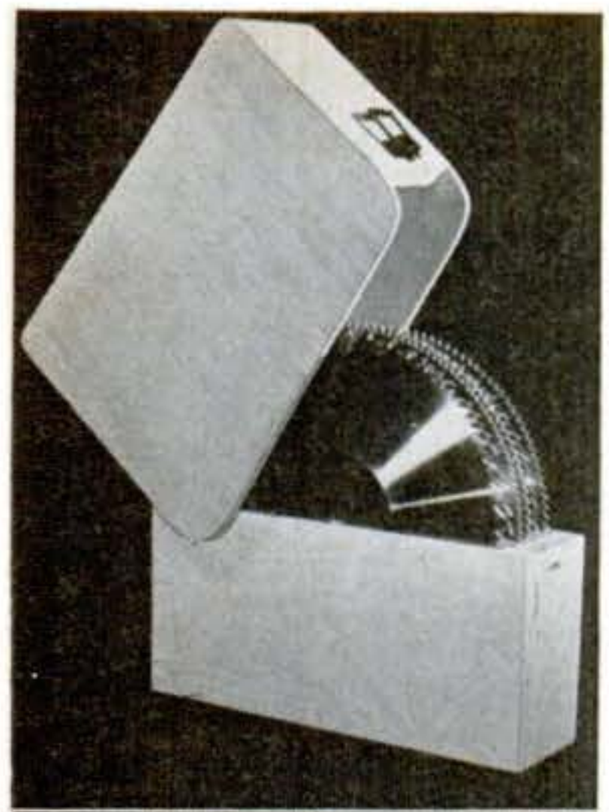
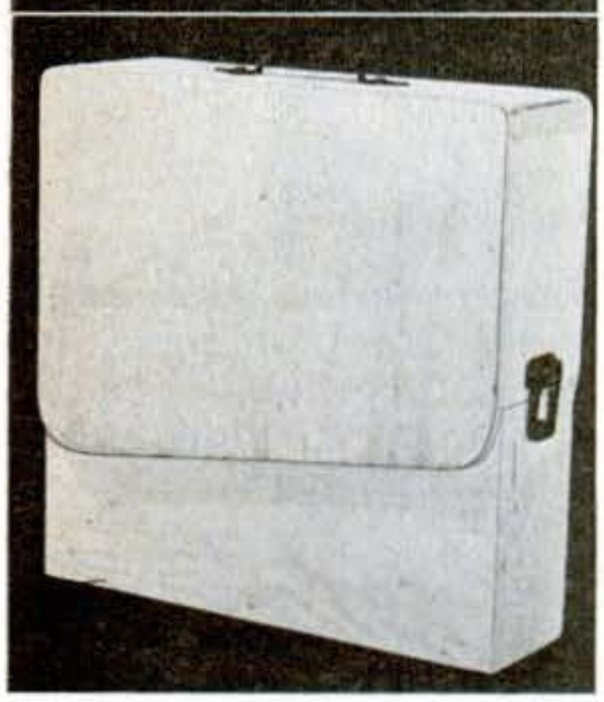
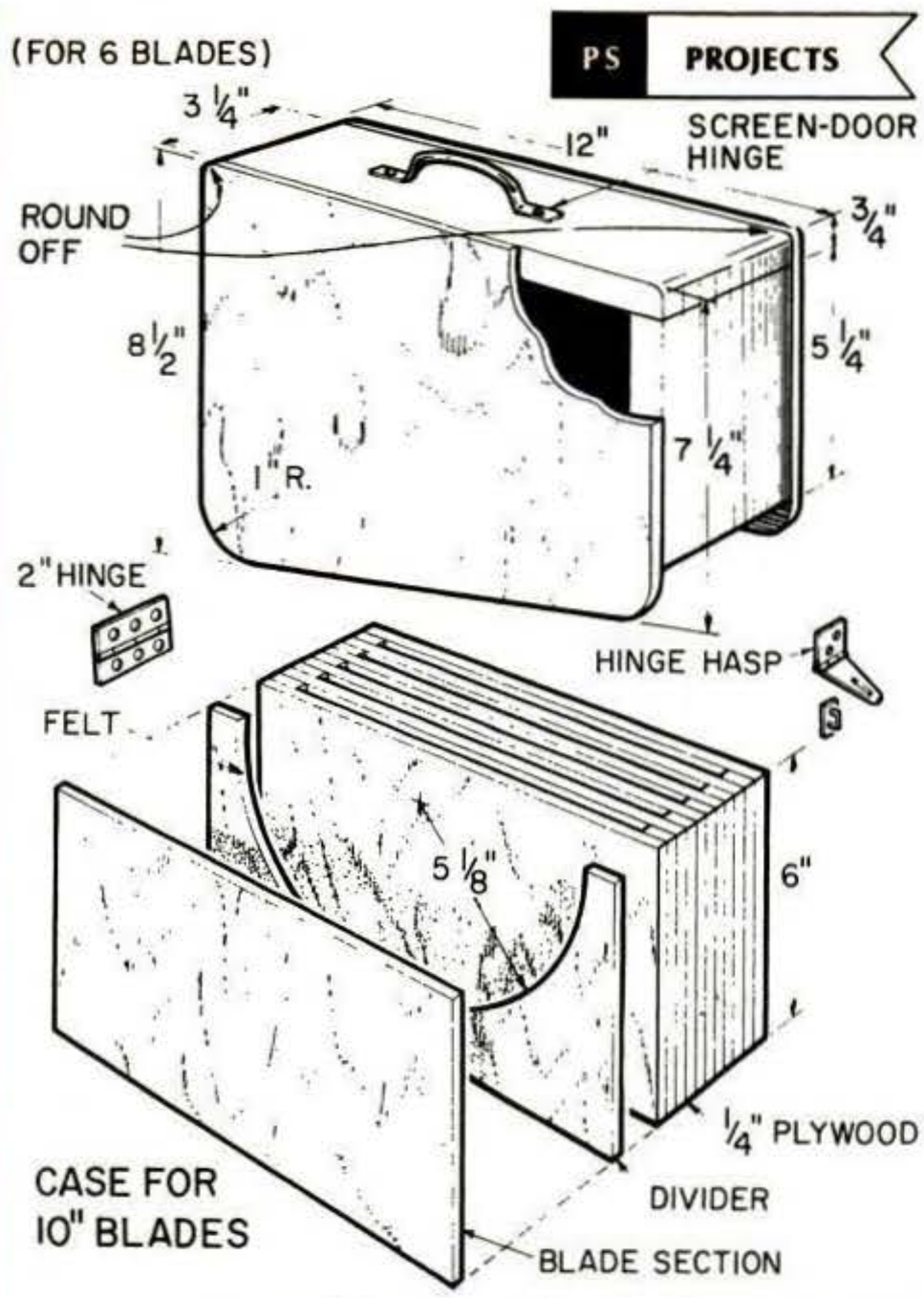






Layers of ¼" plywood are built up into compartmented case. Add more layers to store more saw blades than six this one takes.

Two Storage Safes for Your Best Saw Blades

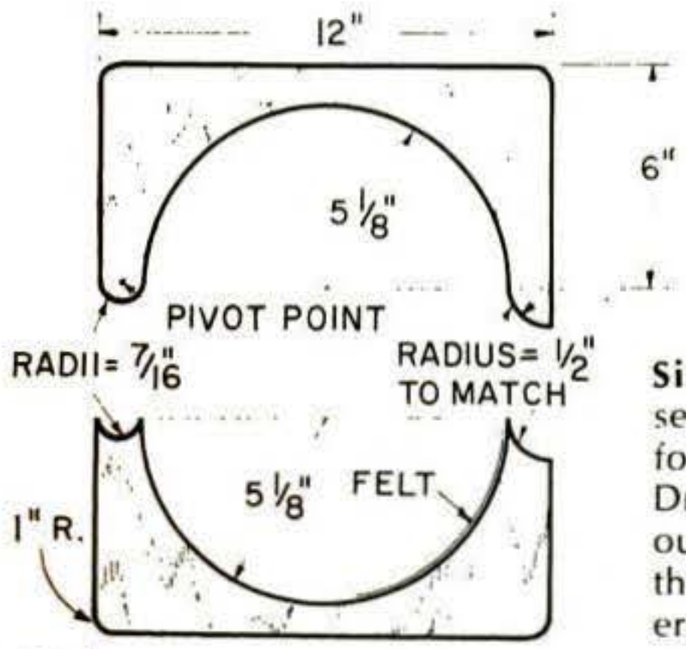
Made of a good grade of plywood, these cases will provide maximum protection for your circular-saw blades. The large one (above) is dimensioned to hold six 10" blades, but the openings may be changed to suit other sizes. In fact, you might want different sizes in the same case. Make the radius of each recess ⅛" greater than the blade radius.

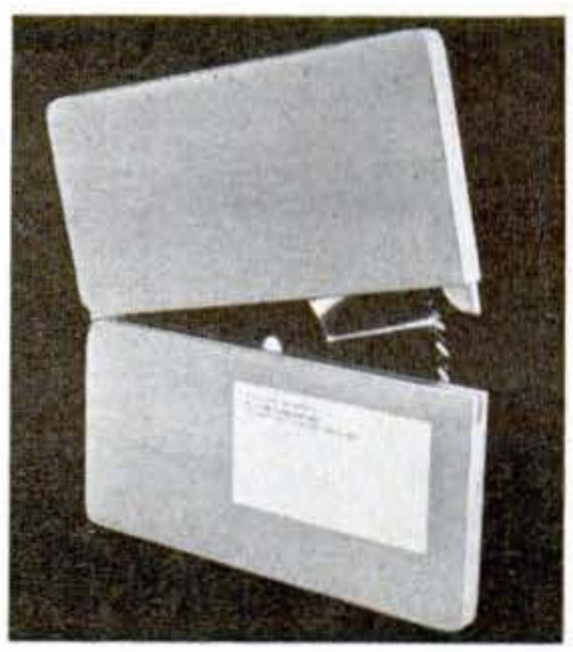
Best bet is to make the blade compartment first. Cut the plywood pieces to overall size and then draw the semicircle on one piece. Stack as many layers as you need so you can make the circular cut just once, using a bandsaw or saber saw.

You can assemble all sections with just glue and clamps, or you can glue and nail separate sections as you go along to build up the stack. In making the cover, note that you need two 3¼"-by-5¼" sections ¾" thick for the front and back. Glue a pad of foam rubber inside the cover to bear down on the blades when the case is closed.

The single case (below) is intended for a very special blade, not only for storage but for mailing to the factory when it needs reconditioning (if that's what you do). The pivot can be just a nail, driven through, cut off, and peened. The lock can be a wood screw through the tab.

Sand the cases smooth and protect them with several coats of a clear sealer.—*R. J. De Cristoforo*





Single-blade case serves as a mailer for a prize blade. Drawing shows layout for middle of three layers. Covers are 6" by 12".

Easy-to-Build Desk

[*Continued from page 111*]

to install drawers or shelves for paper and envelopes, or storage space for a small portable.

The pullout. Assembly is not difficult. Fasten parts (C) to the inside of the left pedestal with 1¼"-#8 flatheads, positioning them ½" back from the front edges. Insert parts (B) and fasten board (D) to the bottoms, making sure that the assembly will slide easily, but not loosely. Finally insert pre-assembled box (A) until it clears the front edge of (D). Fasten a stop cleat to this edge and attach the drawer front.

To vary the length of the slide, simply increase or reduce the width of (D). However, a width of less than 4" is not recommended since the typewriter's weight might be too much for it.

The back panel and brace. Install the back brace running the full length of desk. The back, ¼" plywood, may cover the entire back or just the two pedestals and center-drawer area. In either case, a back is recommended since it provides added structural strength.

If the back of your desk will be visible, the same type of plywood as used in the top is suggested. When fastening this plywood, start at the top and attach with glue and brads, then square up the assembly and fasten similarly along the sides and bottom. Countersink and wood-putty the holes.

The final step is the finishing—one of the most important, but tedious, steps in cabinetry. Begin by filling all holes and flaws with a good grade of wood putty. Sand smooth, but don't overdo it, keeping in mind that the hardwood veneer on most plywoods is quite thin.

Remove all dust from the surfaces before you apply the desired stain. I generally use a good oil-base stain, wiped on with a cloth. Once the stain has set, follow up with several coats of urethane varnish, sanding lightly between coats with a number-320 paper. Knock the gloss off the final coat with fine steel wool, and finish up with paste wax for a deep, low-luster glow. PS

MATERIALS LIST

¾ x 4 x 8 birch plywood	1 panel
½ x 4 x 8 fir plywood	1 panel
¼ x 4 x 8 fir plywood	1 panel
¾ x 2 x 5 fir plywood	1 piece
1 x 6 clear pine	24 feet
Drawer pulls	7
1¼ #6 flathead screws	12
1¼ #8 flathead screws	50

Various brads, finishing nails, white glue, wood putty, oil stain, sandpaper, and urethane varnish

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FISHING & BOATING — The new Heathkit Thermo Spotter lets anglers find the specific water temperature level where trophy fish feed. The new Digital Depth Sounder reading to 199 ft., costs about half the price of other units. In addition there are Heathkit flasher-type depth sounders and fish spotters, power inverters, hailers, VHF phones, etc.

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Uniray—Amazing One-Gun Color-TV Tube

[Continued from page 64]

There must be a better way! That's what most people say when they look inside a conventional shadow-mask TV tube for the first time. Essentially, the tube displays three overlapping images—one red, one blue, and one green—that your eye merges into a full-color picture.

The screen of the tube is covered with a neat pattern of hundreds of thousands of tiny red, green, and blue phosphor dots. Three electron guns inside the tube's neck spew out a trio of pencil-lead-thin electron beams that zigzag across and down the screen in unison and make the dots glow.

The instantaneous intensity of each beam varies in step with the received TV signal so that relative brightness of the dots at each point on the screen varies to create different apparent colors.

Just behind the phosphor-dot array is a thin perforated-steel plate, called the shadow mask, that performs a critical function: It blocks the field of view of the three beams so that each can hit phosphor dots of only one color. One beam strikes only the red dots, one beam only the blue dots, and one beam only the green dots.

Incredible precision is necessary for this system to work satisfactorily; tiny flaws will ruin the picture you see.

If the steel shadow mask becomes magnetized, the beams will be pulled off course, creating color shifts—or impurities—on sections of the screen. The cure is the automatic degaussing gear we mentioned earlier.

The three beams must track together perfectly, or the three colored images won't overlap—you'll see color fringes in the picture. Keeping the beams converged (or intersecting) at

How the Uniray color picture tube works

A single electron gun, positioned in the neck of the tube, produces a stream of electrons. The gun structure is designed to produce a tall and narrow oval-shaped beam, rather than a circular beam as in all conventional tubes. We'll see why shortly.

A set of deflection coils around the tube's neck generates a constantly changing magnetic field that deflects the beam back and forth across the screen in a zigzag pattern that moves from top to bottom.

These coils are similar to the kind used in a black-and-white TV, although they are made with more care to insure a uniform beam deflection pattern.

The face of the screen is covered with an array of red, blue, and green phosphor stripes—approximately 300 of each color, creating a total of about 300 red/blue/green triplets. A thin black divider fills the gap between adjacent color stripes.

A thin layer of aluminum is deposited across the rear surface of the phosphor-stripe array. Electrons can pass through this layer without difficulty, but light cannot. Its function is to prevent light produced by the phosphor stripes from entering the picture-tube bell.

Atop the aluminum layer is a set of index phosphor stripes, intended to produce blips of light within the tube as the beam scans across the screen. These index stripes are positioned atop every other one of the black dividers that separate adjacent colored stripes.

Note that there are also index phos-

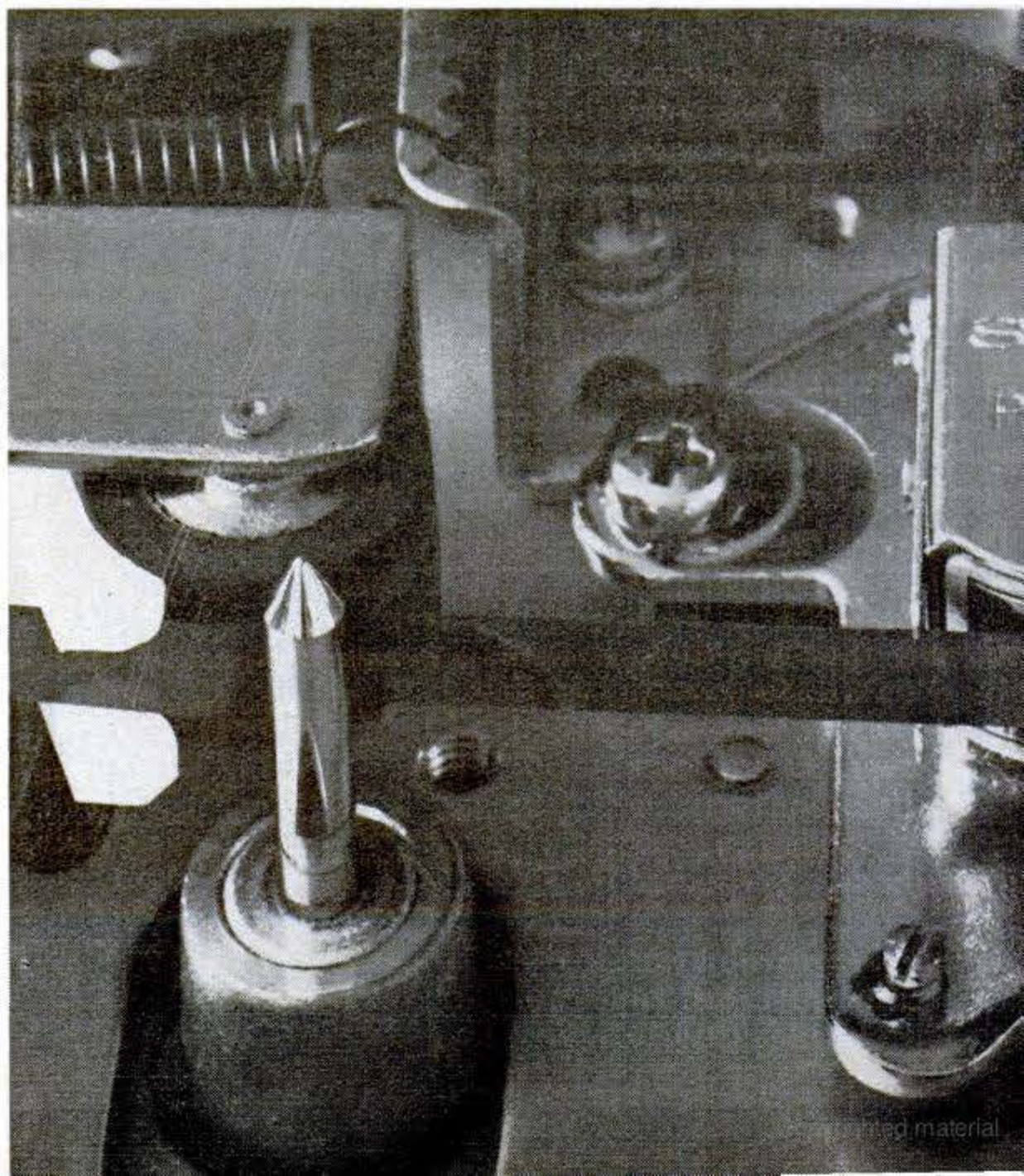
Wow and flutter 0.1%, lowest of any stereo cassette deck at any price.

Sony's exclusive closed-loop dual capstan tape drive system solves a major cassette problem—pronounced wow and flutter. This system (shown here) helps make the Sony 160 and 165 stereo cassette decks perform better than any other. Why? Because it drives the tape at a constant speed, exerting the *same amount of tape-to-head pressure from one end of the tape to the other.* (Not only a steady pressure but the correct amount of pressure to reduce modulation distortion drastically.)

In addition, both Sony decks are equipped with a built-in Peak Limiter. A unique first, it automatically monitors the recording level preventing tape saturation and distortion without audibly altering the dynamic range while you're recording.

There is also a tape select switch that enables you to change the record equalization for either standard or the new chromium dioxide cassette tapes.

Sony keeps the



the surface of the shadow mask requires the complex convergence circuitry that is the hallmark of a conventional color TV.

RCA developed the shadow-mask tube about two decades ago, and since then hundreds of millions of dollars have been spent all around the world trying to come up with a simpler replacement. But, like the old-faithful reciprocating gas engine, it's durable: None of the many contenders has been able to knock it out of the box.

"This could be the one." A senior engineer at one of the major color-set makers told me that the Uniray is the first real potential challenger to the shadow-mask tube that he has come across. There are still problems to be solved, but the basic Uniray concept seems practical.

Most of the shadow-mask tube's woes stem from its three separate beams. The Uniray has only a single beam that scans across a screen covered with vertical phosphor *stripes*, arranged in sequences of red, blue, and green stripes.

The one beam must do the job of three as it makes each tiny element of phosphor glow with a different brightness to create the apparent full-color picture you see. This means the beam must become the "red beam" when it passes over a red phosphor stripe; it must be a "blue beam" when it hits blue phosphor; and it must be a "green beam" when it strikes a green stripe.

Back in the set's chassis, an electronic switching circuit sequentially connects the beam drive circuit (the stage that controls the beam's intensity) to the red, blue, and green signals derived from the incoming TV signal.

Continued

phor stripes on the bell wall adjacent to the left edge of the screen (as viewed from the front). These starting stripes are scanned by the beam before the beam reaches the screen. They are spaced three times as far apart as the index stripes.

As a single scan—or sweep—of the beam begins, the beam first strikes the starting stripes and creates a series of light blips within the tube. These blips are "seen" by a photomultiplier tube that "looks" through a window in the bell of the tube.

This window is a small area where the tube's black-carbon conductive coating has been scraped away.

The photomultiplier tube is an exceptionally sensitive light pickup, which generates a small output pulse each time it sees a blip of light.

These output pulses are used to synchronize the beam-switching circuitry, as explained in the text. The starting stripes are more widely spaced than the index stripes, to insure that the beam switching circuitry starts in precise step with the scanning beam.

As the beam moves across the colored phosphor stripes, it makes the area struck on each emit a pinpoint of colored light. In one scan, the beam "paints" one line of the picture you see. An image is completed in 1/30 second.

Note that the shape of the beam matches the shape of the phosphor stripes: The tall and narrow beam strikes a single stripe at a time, without "overlapping" onto adjacent stripes.

As we've said, the beam sweeping across the index stripes as it scans across the face, generates a continuous chain of light blips within the tube that keeps the beam-switching circuitry synchronized with the beam motion.

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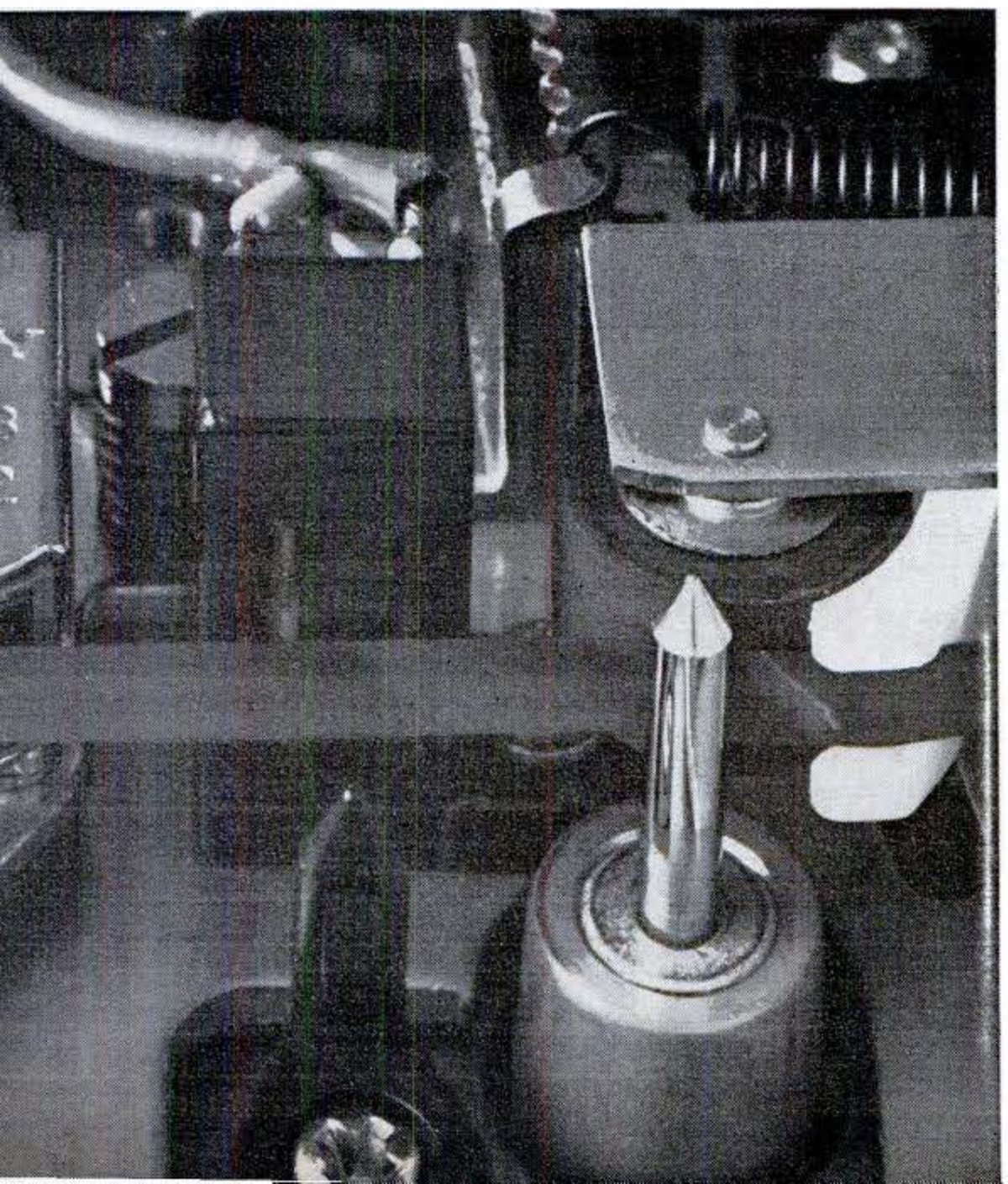

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Uniray—One-Gun Color Tube

[Continued]

Thus, as the beam scans across the phophor stripes, it illuminates each element of each stripe to the specific relative brightness necessary to produce a specific color at each point on the screen.

But there's a rub: How does the set's circuitry "know" when the beam is over a red, or blue, or green stripe? The answer: It really doesn't know; it must constantly be told.

This problem of how to keep the electronic switching circuitry synchronized with the beam's motion kayoed the early single-beam color-picture-tube designs.

Sunstein's solution is simple and ingenious: He places a second set of phosphor stripes behind the color stripes, and aimed backward into the tube. The secondary stripes are positioned atop the black dividers between the red, blue, and green color bands, and are spaced so there is one stripe above every second black divider. These phosphor stripes glow white when struck by the beam.

As the beam scans across the screen, the white phosphor stripes emit a progression of pinpoints of light inside the tube. A photomultiplier tube —a very sensitive electronic eye— "sees" this steady series of light blips and generates a matching chain of output pulses that synchronizes the set's beam-switching circuitry.

The photomultiplier peers into the tube through a transparent window in the funnel. Incidentally, light from the colored phosphor stripes doesn't reach the photomultiplier, because of the thin aluminized layer just behind the phosphors.

Sunstein planned the location of the index strips (the white phosphors) to minimize synchronization errors caused by variations in beam size as beam intensity changes. You need a mathematician to prove it, but any errors tend to cancel themselves out.

The term "index" means that the stripes generate index signals that pinpoint beam location. In general, this type of color tube is known as an index-beam system.

It's not perfect yet. One TV engineering expert warned of three possible shortcomings of the design:

- Because all the index stripes must be struck by the beam as it scans across the screen (in order to maintain synchronization), the beam intensity can never drop to zero. This means that "black" areas in the picture aren't as dark as on a conventional TV.
- Since a "spot" of white light in your picture is created from *side-by-side* red, green, and blue pinpoints of light, it's actually a squat blob—rather than the nearly round dot created by a triangular cluster of phosphor dots. Theoretically, this affects image sharpness.
- The vertical array of color stripes is discernible at close viewing distances.

Frankly, I wasn't bothered by any of these phenomena whenI viewed the prototype. Moreover, Sunstein told me he is working on mechanical and electronic modifications, and on supplemental optical filters, to still further minimize them in production models of the Uniray.

The shadow mask isn't dead. Right now, the designs of the '73 color sets are virtually locked in, so it will be 1974—or more likely 1975—at the earliest before Uniray is available in production TV sets, assuming Sunstein can convince set makers—and tube builders—to turn away from the shadow-mask tube. But Sunstein is committed to his design. He told me that if the big set manufacturers don't switch to Uniray, he will start building sets himself. And so, one way or another, it looks like the venerable shadow-mask picture tube may have a short future. PS

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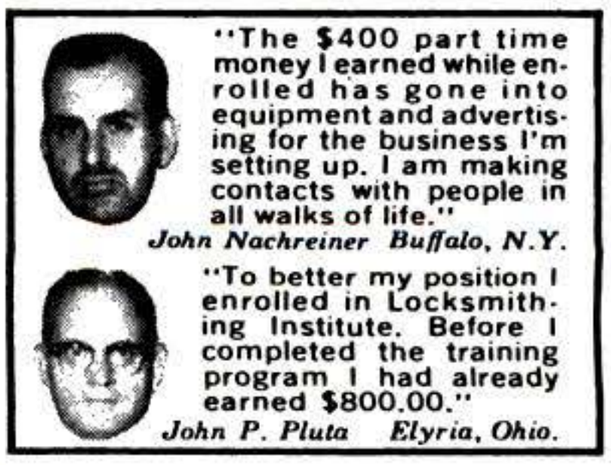
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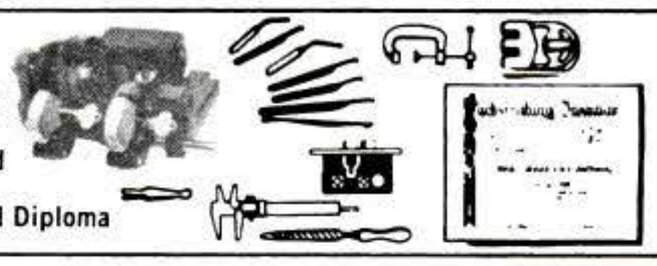

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Space-Age Dogfighting—It's a Wild New Ball Game

[Continued from page 76]

I braced myself for the dive to 20,000 feet. Instead, Woelfel hesitated momentarily, and rolled it all the way through in a barrel roll, pulled it into a tight descending turn, and started back up again.

I nearly passed out. Woelfel was improvising maneuvers I wasn't prepared for. As the blood drained from my head, he asked casually, "See the F-4?"

I forced my head up. Sure enough, there it was in front of us, jinking back and forth, swishing its tail around going straight up. It was the first time I'd seen the enemy. Woelfel had not only seen it, but maneuvered behind it.

The controller broke off the engagement, and, on the way back to our rendezvous point, I asked timidly, "What happened?"

"Well, it wasn't a good mission. On an intercept, the first two planes should distract the escorting fighters, so Three and Four can go after the Strike Force. I guess they couldn't hack it, so they went after the bombers instead. I had to switch and go after the fighters."

Combat isn't the classroom. The enemy doesn't always do what you'd like it to do, and even the best textbook tactics can be improved on.

One more run. We formed up, and almost immediately the controller warned us there was new trouble. Two of the F-4s had shot out 25 miles ahead of the Strike Force. Smart move. The Navy pilots had changed their tactics so we'd have to divide our attention between them and the Strike Force with the remainder of the escort.

I spotted the F-4s this time, flashing by below us, then coming up in a steep climb. Woelfel had seen them, too, but he waited. He had to know what Red One and Two would do. They kept going toward the Strike Force. Good men. They were ahead of us, closer to the Strike Force. The F-4s were now our responsibility.

"We'll have to take these guys on," Woelfel said, as he rolled the 106 over on its back once more. This time we completed the dive, screaming to the bottom of the eggshell while the Navy fighters were going up the other side. We followed, and when we leveled out again, we were all in tandem, two 106s behind two F-4s behind two 106s.

But we had the advantage. Starting from a higher altitude, we had more closing speed. Ed could go into a simple straight-ahead barrel roll to keep from overshooting while maintaining his superior speed.

Another smart move. One of the F-4s broke off, up to the right in a yo-yo-like maneuver. Woelfel kept going. I knew what he was thinking. Get the sure one. Defend your friends.

The other F-4 stayed too long. Woelfel moved in on him handily, with one simple barrel roll, and called in an MA—mission accomplished—before he broke off.

Up to this point I had followed the strategy. Then it got wild. Woelfel whipped the plane up into a screeching, tight-climbing turn—in full afterburner, "turning and burning"—then into a series of the most violent maneuvers I'd ever been through, all at high g's: scissors, rolls, spirals, yo-yos, up and down, and over and out. Obviously we were in trouble. The F-4 that had broken off had got around behind us, and Woelfel was fighting for his life—and mine. We lost.

On the radio we heard that Red One and Two had indeed got through to the Strike Force—another MA. But on the way home, Woelfel said, "We got some, but they got us, too." PS

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Liquid Crystals: Those New Electronic Showoffs

[Continued from page 79]

instant depend upon the voltage applied to the electrodes.

When 7 makes 10. The numerical display I saw at RCA consists of two glass plates sandwiching a thin LC film. The rear plate has a large transparent-conductor electrode on its inner surface (in contact with the LC film); the faceplate has seven individual bar-shaped electrodes (also transparent) arranged in a squared-off figure *8*.

Any digit from *0* through *9* can be created by connecting different combinations of the front seven segments to the power supply, together with the common rear electrode.

Although the device will work with an applied DC voltage, AC voltages are usually recommended to prevent electrochemical reactions within the film. The changes, caused by a steady current flow, are minimized with AC because the continuously reversing current flow tends to undo any damage it just did.

This type of display is called a *transmissive* device, since ambient light must travel through the module from back to front for a viewer to see the displayed digit.

A *reflective* display is built by making the rear electrode out of a thin layer of shiny metal film. The viewer sees the white digit against the metal background when the display is illuminated from the front.

Happily, the viewer sees the digit more clearly as ambient light increases. By contrast, pilot lamps and LED displays can be washed out by bright ambient light. Thus, LC displays are naturals for daylight-filled aircraft cockpits and cars.

Reflective displays will probably win out for use in wristwatches, calculators, dashboard displays, and other instrument applications, since front lighting is more readily available than rear lighting.

Transmissive LC devices may eventually find their way into strange places: at the top of your car's windshield, to act as an electronic "sunvisor" that clouds up at the touch of a button; in your bathroom window, to serve as an electronic "window shade."

Liquid-crystal technology can do more than merely show numbers!

Problems, problems. There are a few that must be solved before LCs will be suitable for all potential applications.

Operating temperature is an important one. Here, the rub is extremely low ambient temperatures. A winter morning in Minnesota (and most other Northern states), for example, would freeze solid an LC auto speedometer of any existing LC material. Fortunately, chemists are coming up with new LC substances at breakneck pace.

A bit more ominous are the problems of life span and decay time. Long life is an obvious necessity. Designers of watches and calculators are pressing for a minimum five-year lifetime for their LC displays, but most displays built to date drop dead at a much younger age.

Note that "most": Albert Medwin, Ragen's President, told me that the LC display used in the firm's calculator has a 10,000-hour life span. This works out to five years of hard usage . . . for a calculator.

But, in a wristwatch, 10,000-hours represents slightly more than one year of continuous display operation.

Decay time—the time it takes for the display to "turn off" and revert back to the transparent state—is of prime importance in TV applications. In order to create an image containing a full range of tonal values, each tiny element making up the screen must be able to flash on and off thousands of times each second. But, in present LC substances the molecules take upwards of 1/10 second to realign, permitting only about 10 flashes per second.

Can the problems be licked? I asked Dr. Glenn H. Brown, director of the Liquid Crystal Institute at Kent State University. Dr. Brown explained that life span can be boosted considerably with improved device packaging. The trick is to keep moisture, air, and ultraviolet light away from the sensitive LC molecules. Tight seals, glass designed to filter out UV light, and UV absorber chemicals will probably do the job.

Decay time is another story. The molecules move slowly because they are large; Dr. Brown expressed little confidence that decay time will ever be made short enough for TV-image generation. But, he couldn't be sure that it wouldn't be, either.

Finally, there's the question of cost. The LC material itself is fairly inexpensive. However, building the precision glass sandwich—and maintaining the 1/1,000-inch film thickness—is tricky.

RCA's sample LC digit displays go for $25 apiece—but every expert I spoke to predicted a cost-per-digit of between 50 and 75 cents when LC displays go into mass production.

When will that day come? Considering the great number of exciting LC applications, I'd say before this year is out. PS

New Outboards for '72

[Continued from page 107]

can manufacturers are "drainless." Any unburned fuel that condenses in a two-cycle motor's crankcase is completely recycled and converted to power. No unburned fuel is discharged in the water.

All this and dependable, too. They got that way through tough testing. The lead-walled high-speed centrifuge at Outboard Marine Corporation's engineering center in Waukegan, Ill., spins flywheels at increasingly higher speeds until they fly apart. The pieces are analyzed and the findings used to design a flywheel that will last for years at normal rpm.

"Cold rooms" reproduce bitter cold on call, testing the ability of an outboard to start. Paints and motor parts are exposed to sun and to heavily concentrated salt-water baths to find those materials that can best resist the corrosive effect of sea water and the intense heat of summer.

The toughest testing ground of all is the world-wide circuit of competitive outboard races. When a motor performs wide open for six or eight hours under racing conditions, a part may fail. When that happens, the motor is taken back to the engineering center and carefully disassembled to find the reason for its failure. Once the fault is determined, a solution is not long in coming—a solution that may improve the performance of your own outboard.

"The first V4 outboard introduced in 1957 was just 50 horsepower," said Jack Leek, high-performance chief for Johnson Motors and Outboard Marine Corporation. "Today, that same basic V4 block has more than doubled its stock horsepower. Much of that power gain is attributable to what we've learned in racing the V4."

Other examples of production features standard in various Johnson outboards that were developed through the company's racing program include the pressure-back piston ring; the tuned exhaust, which offers more power with less noise; more efficient air-intake systems and combustion-chamber designs; and the new stainless-steel, teflon-coated propellers.

Outboards are enjoyable. They open up to you and your family a multitude of worlds:

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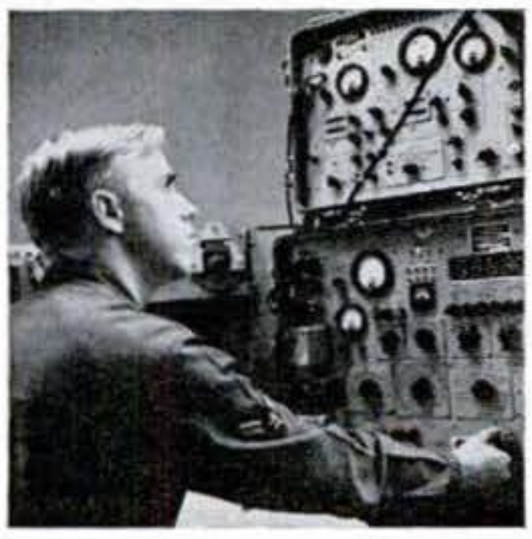

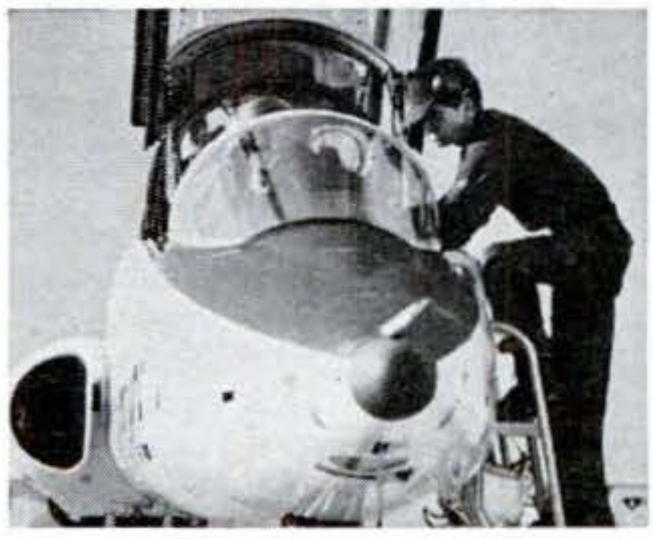

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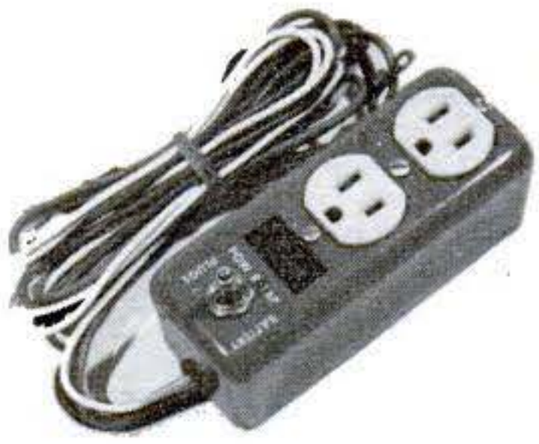

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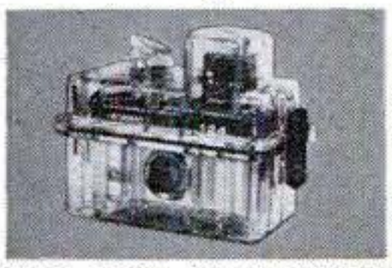

Ingenious air and water-tight case lets you use your Instamatic®100, 104, 124 or 134 Camera anywhere, without fear of damage. Shoot underwater, and in rain, snow, sand. Unbreakable plastic case, tested in sea water 100 ft. deep, floats, keeps your Instamatic safe, ready for pictures you've been afraid to risk before. Just insert camera w/flash cube atchd., replace cover, and shoot! Fast lever action advances film for next shot, rotates flash.

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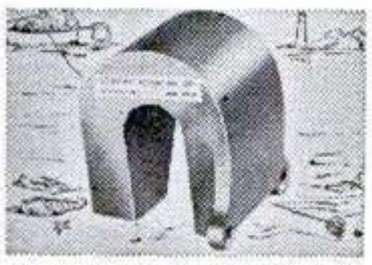

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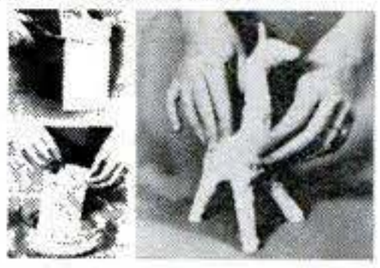

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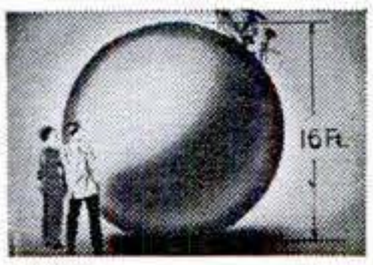

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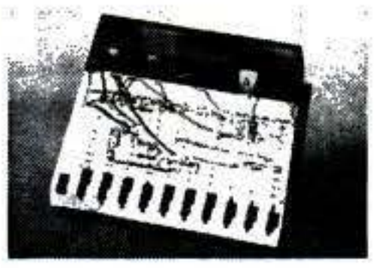

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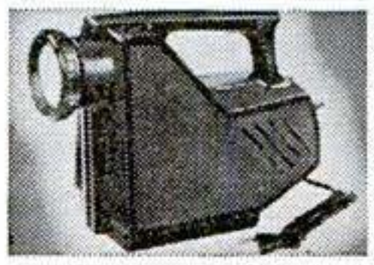

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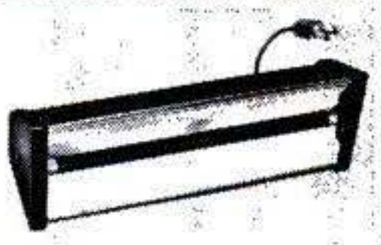

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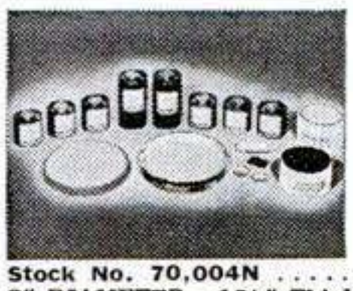

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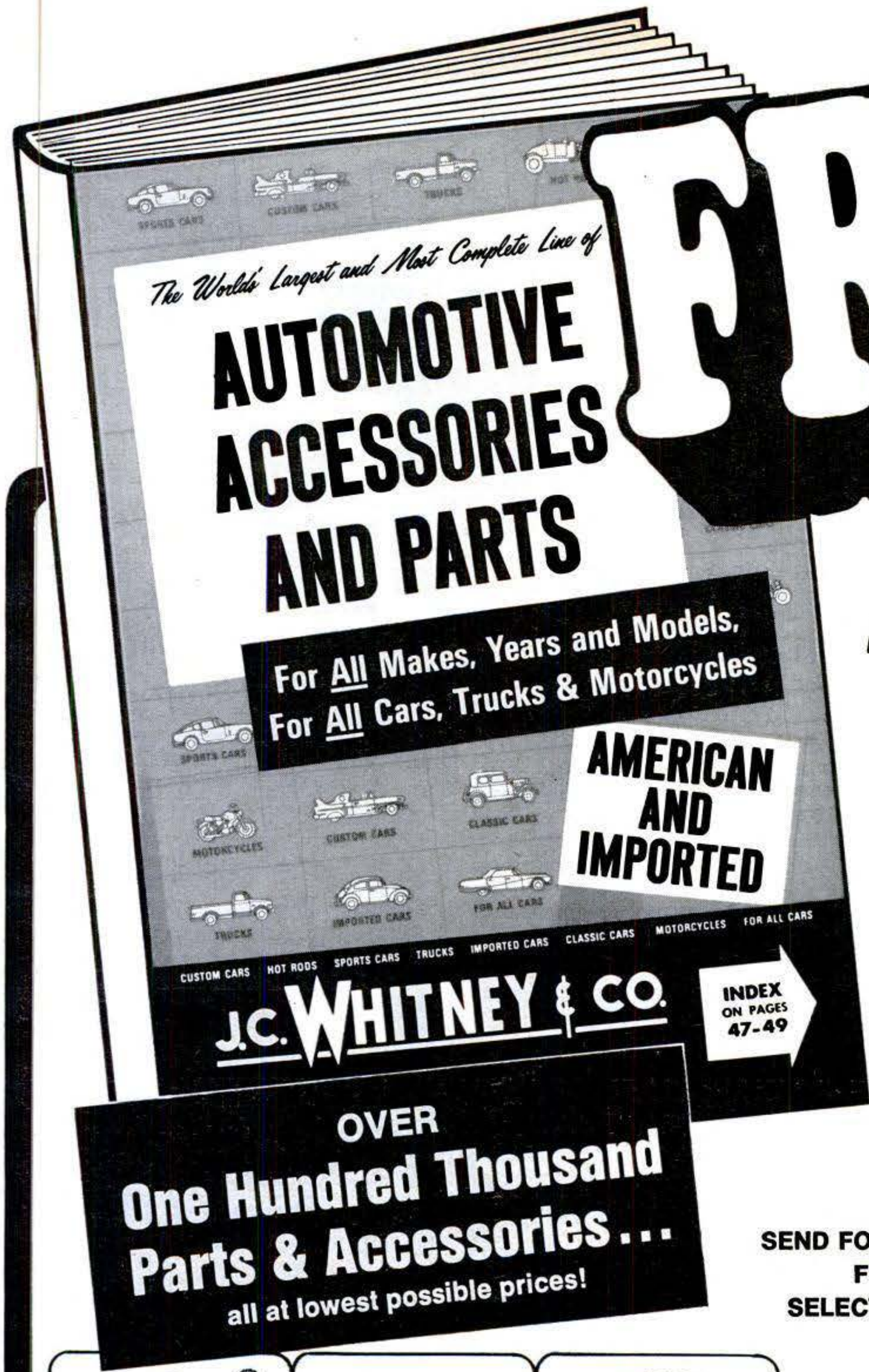

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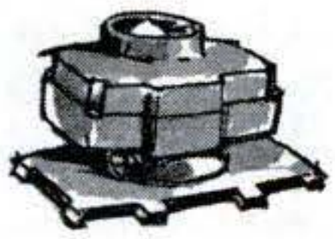

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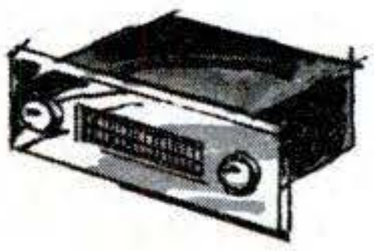

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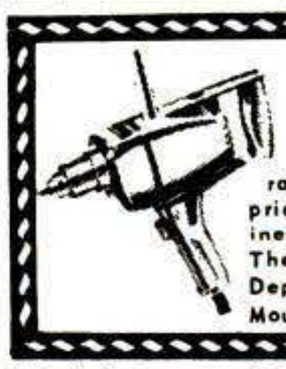

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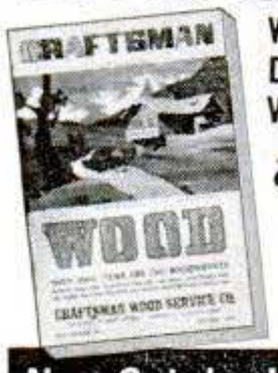

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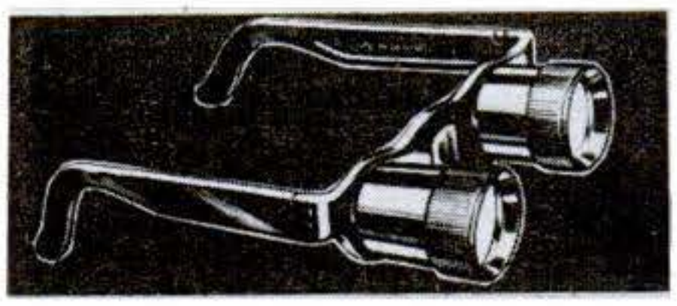

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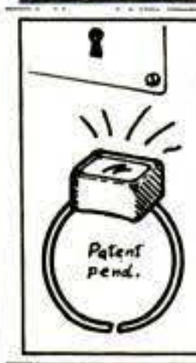

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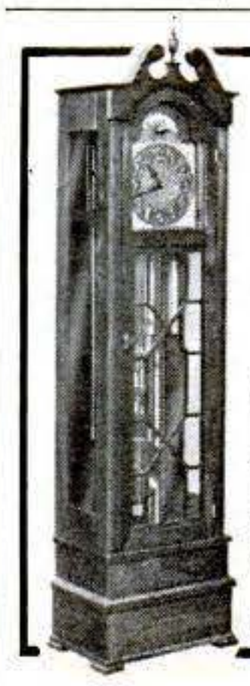

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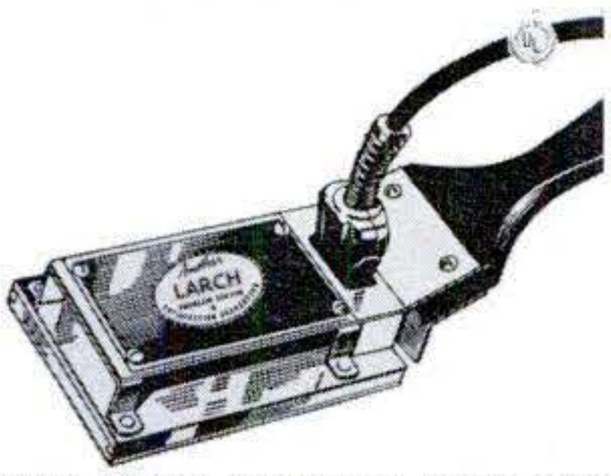

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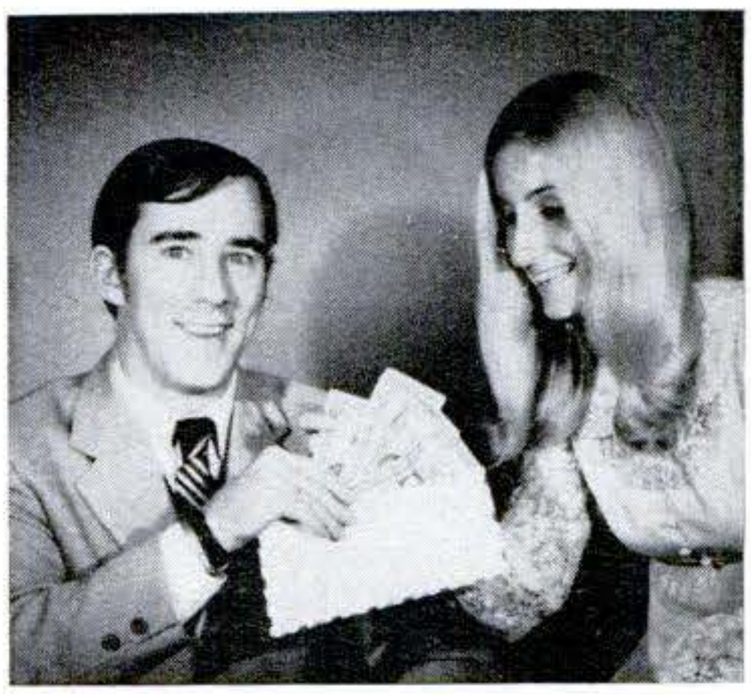

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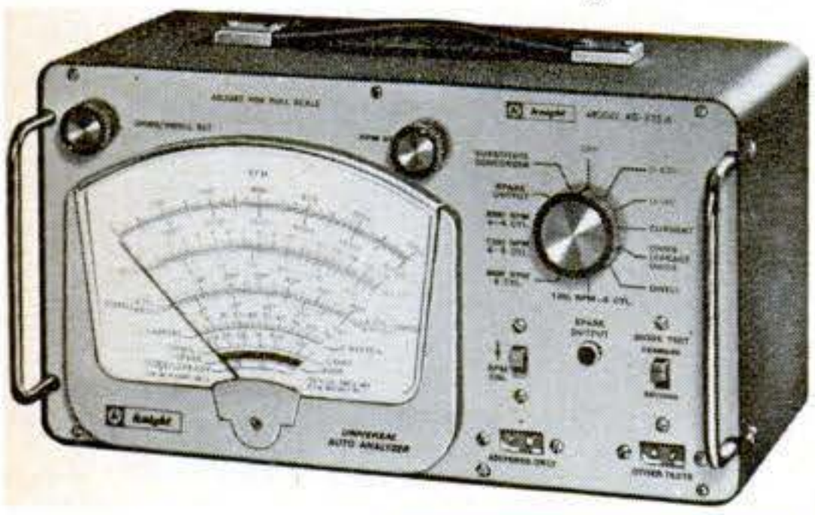

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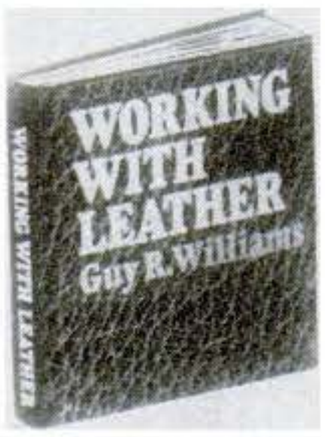

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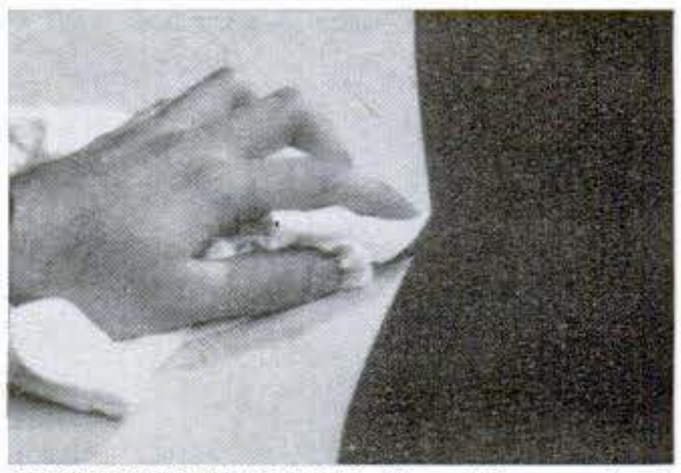

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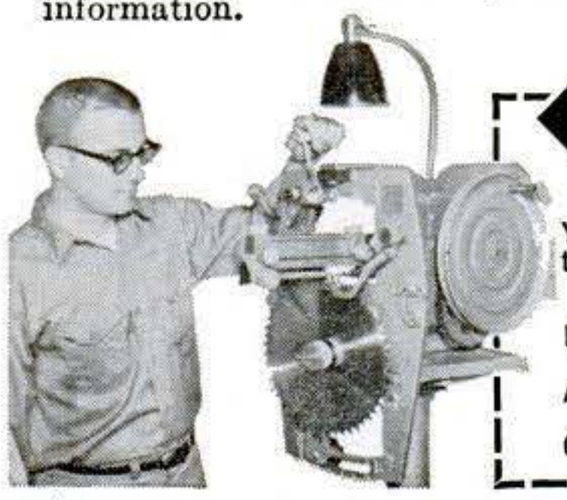

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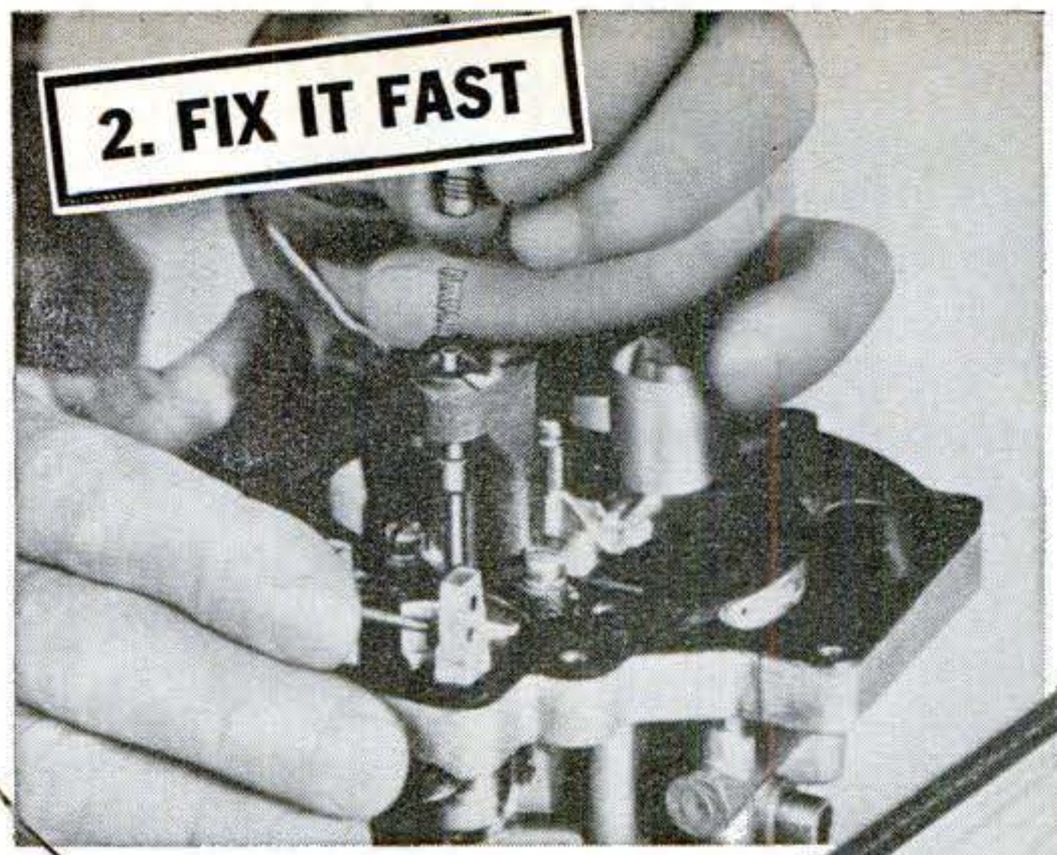

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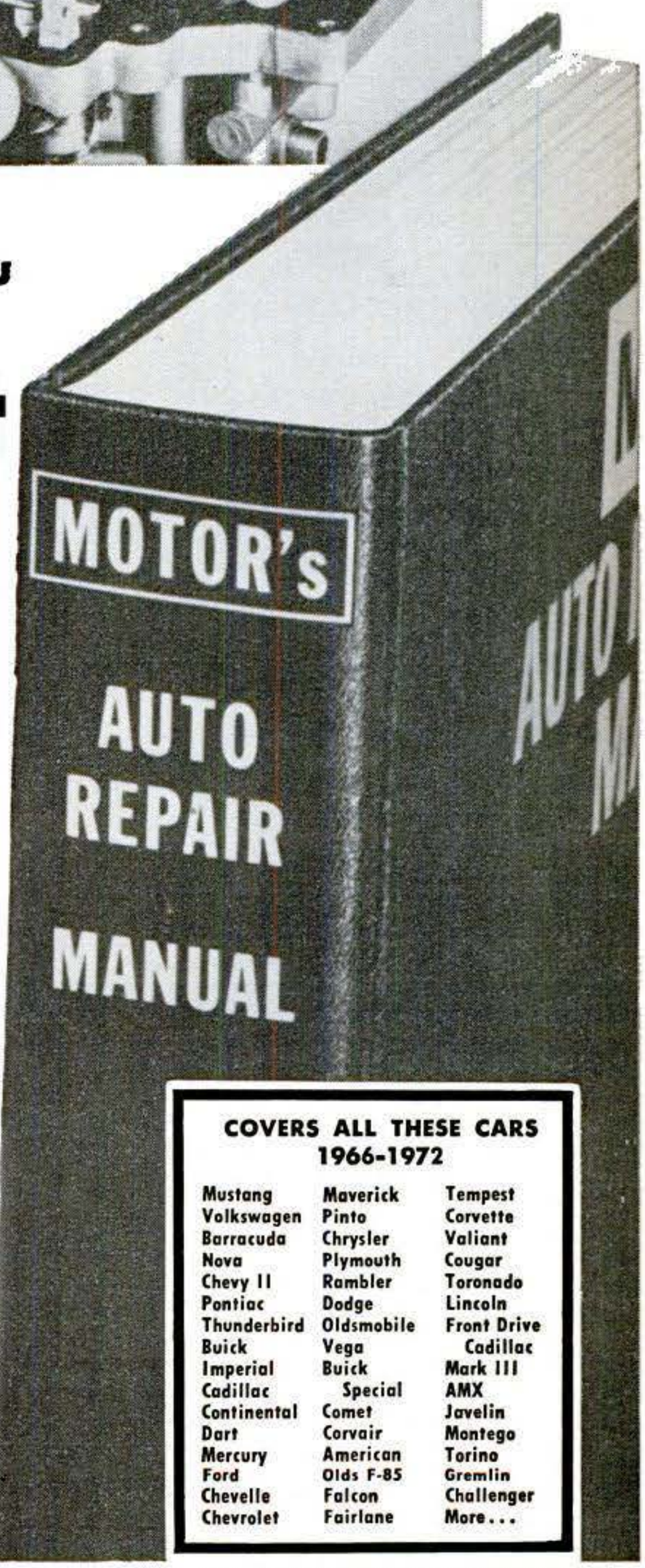

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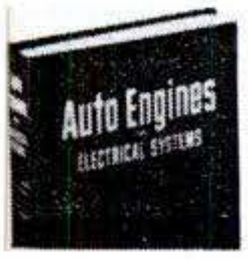

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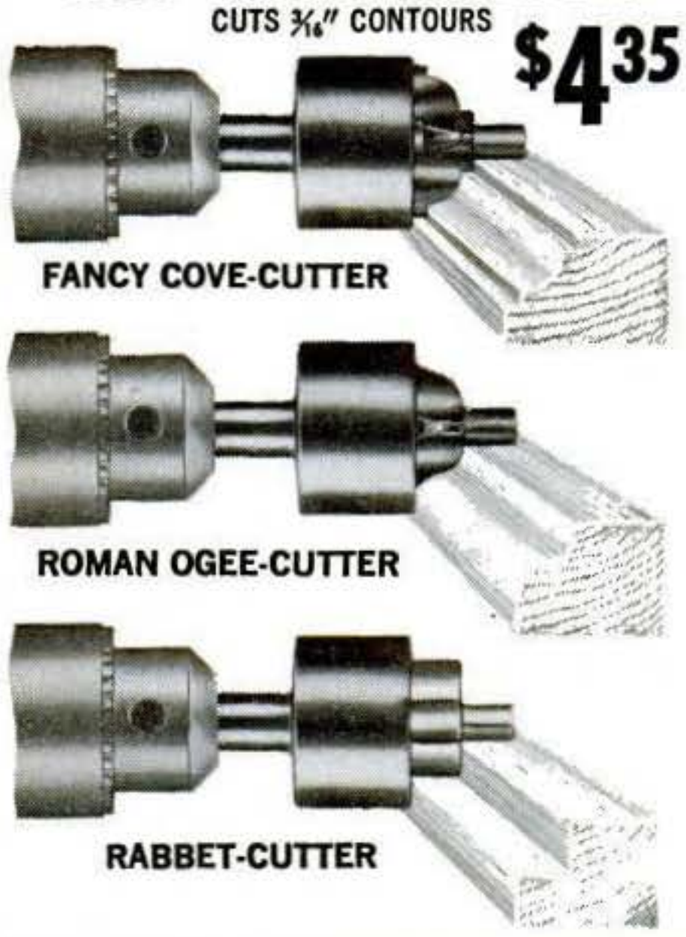

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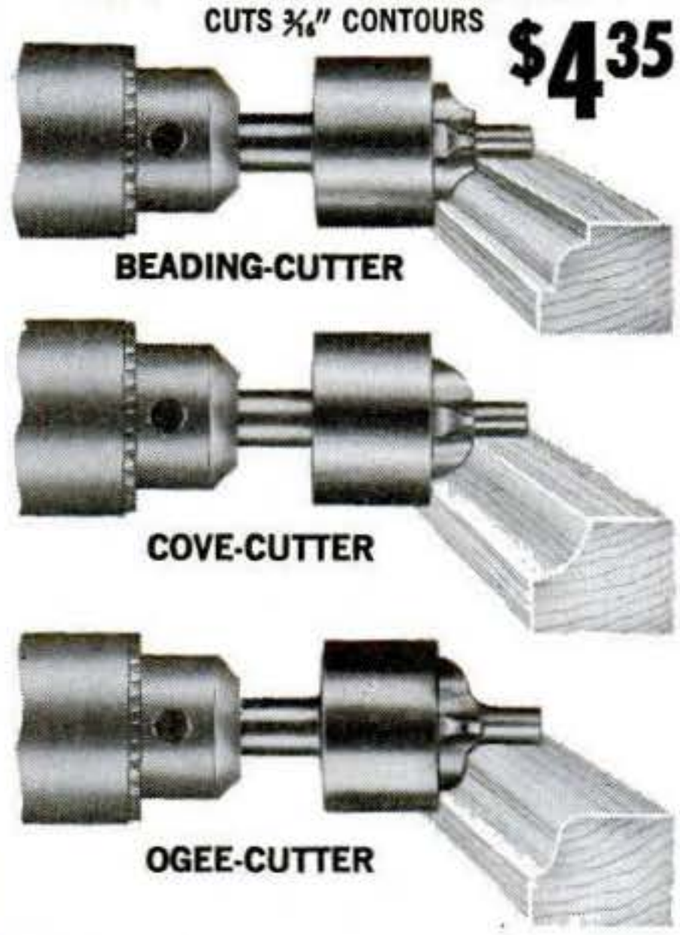

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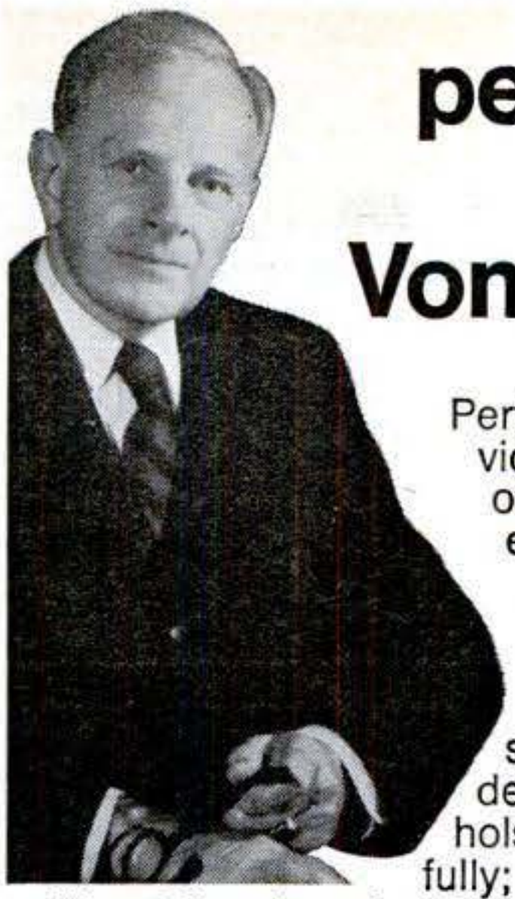

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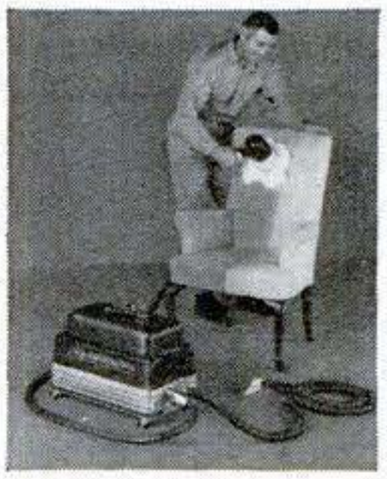

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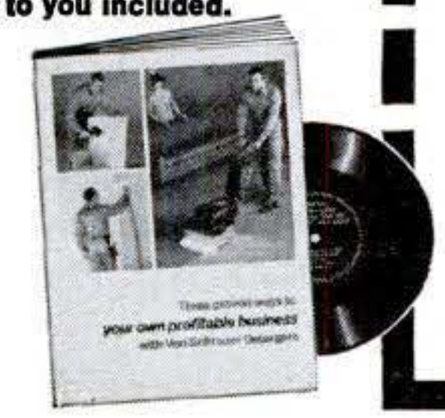

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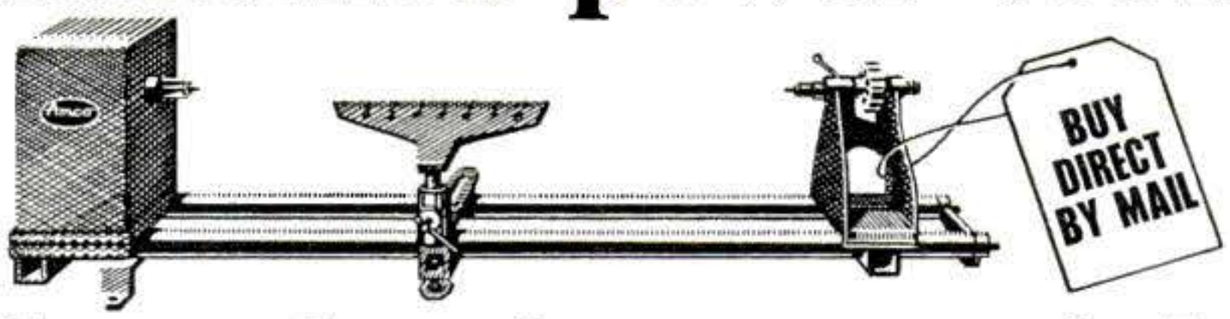

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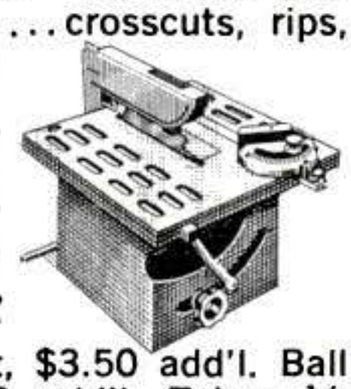

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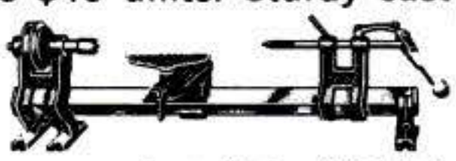

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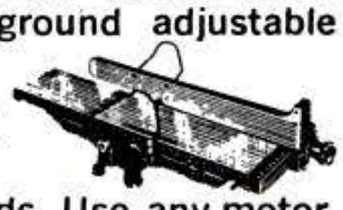

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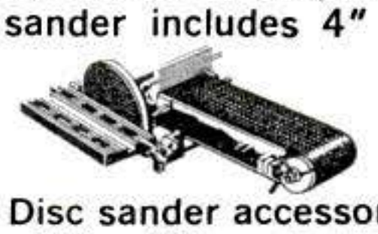

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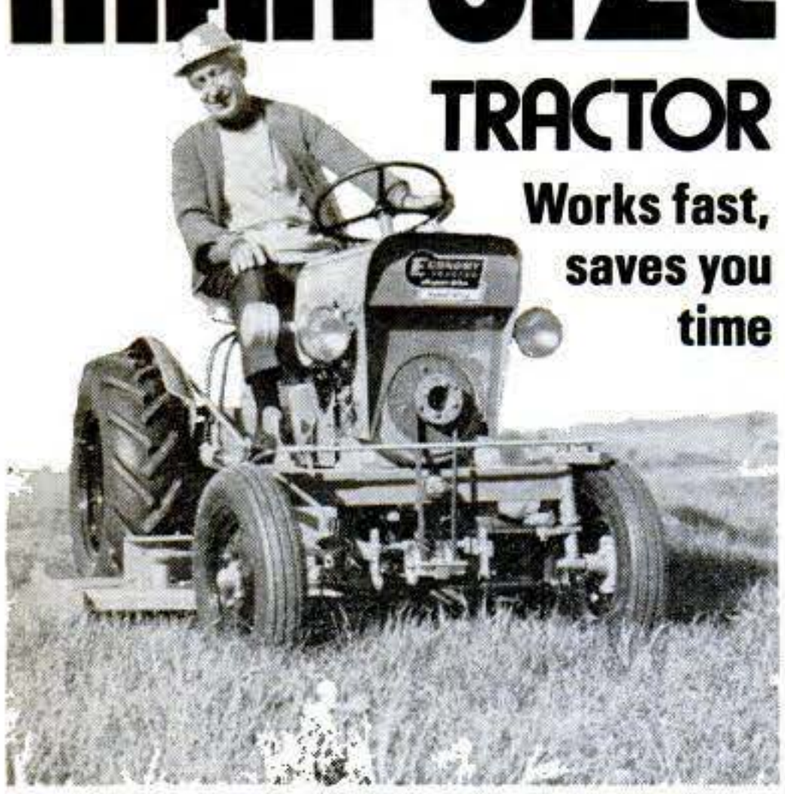

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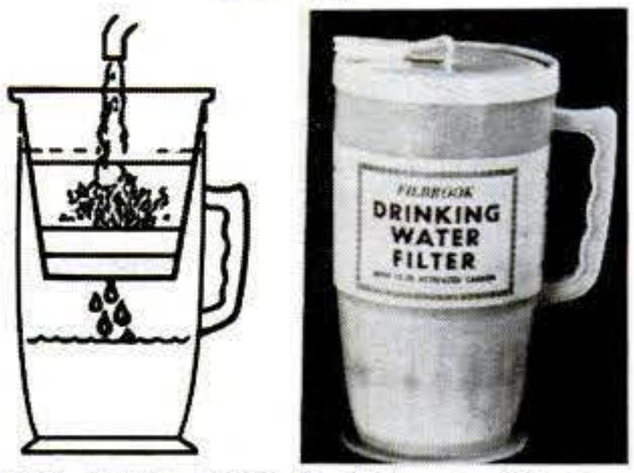

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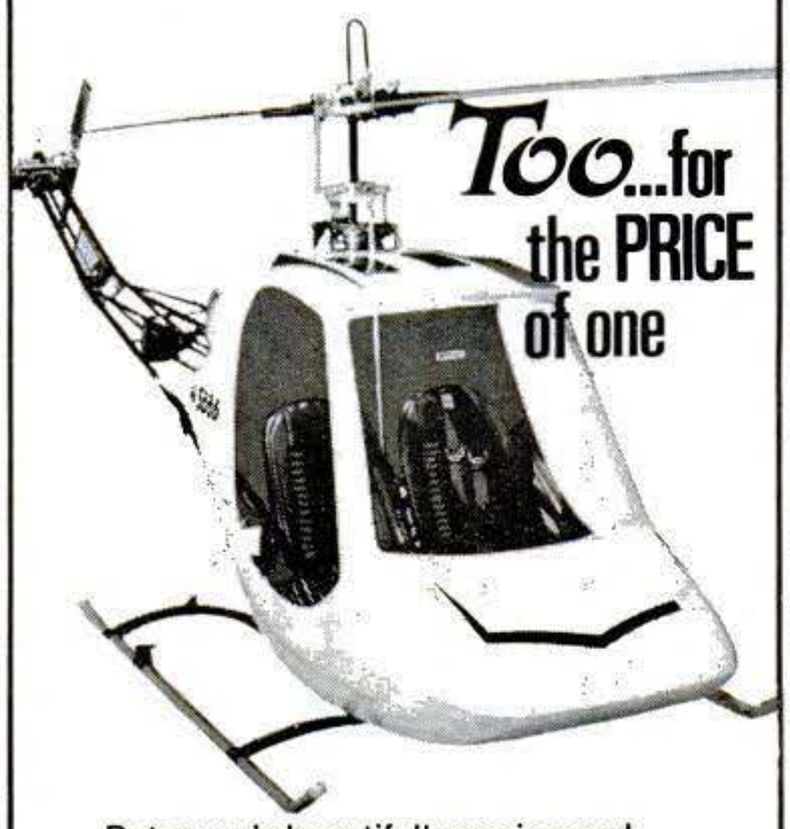

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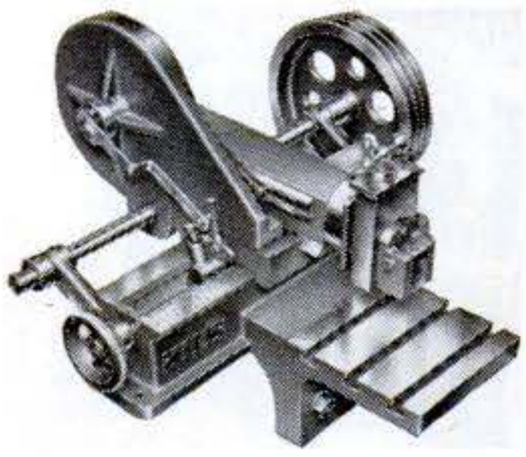

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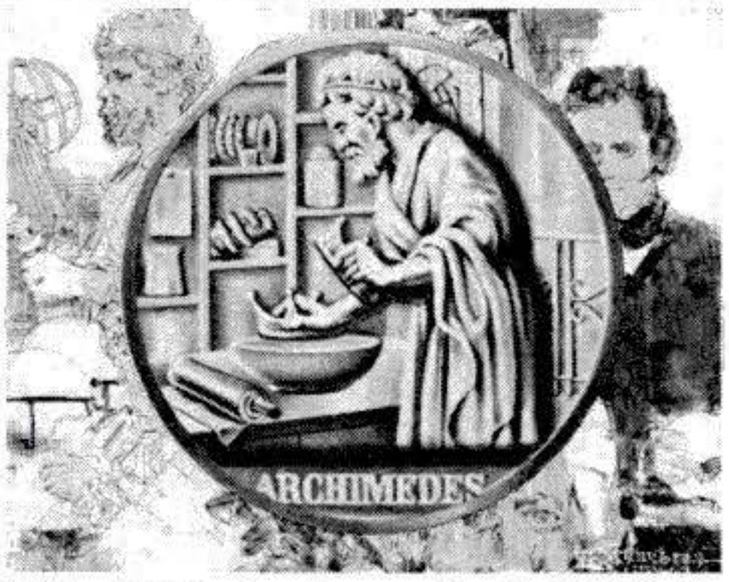

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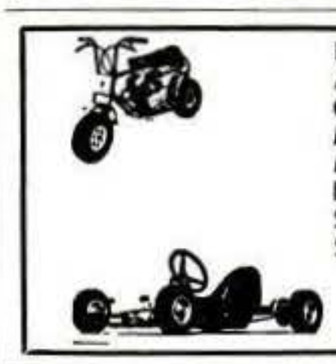

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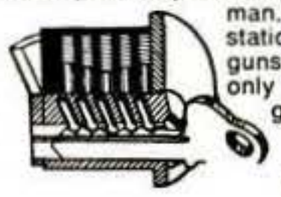

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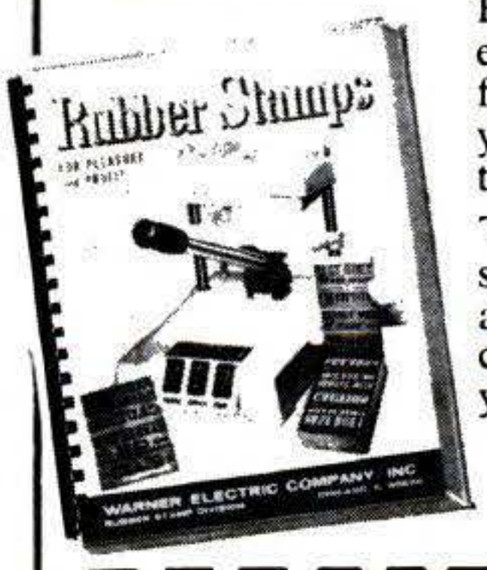

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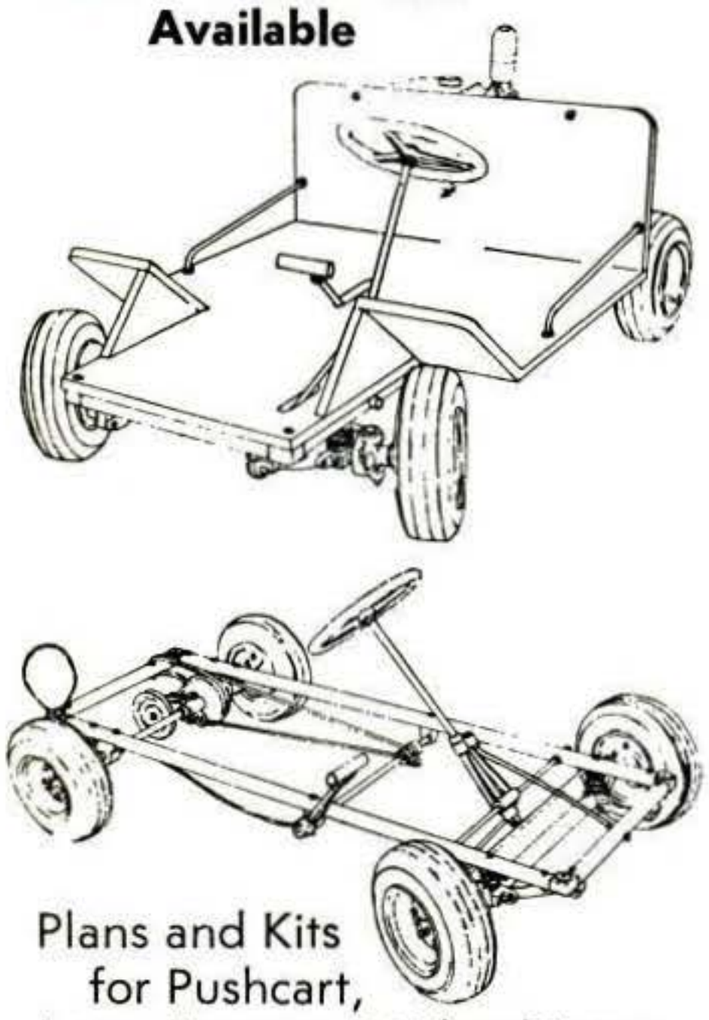

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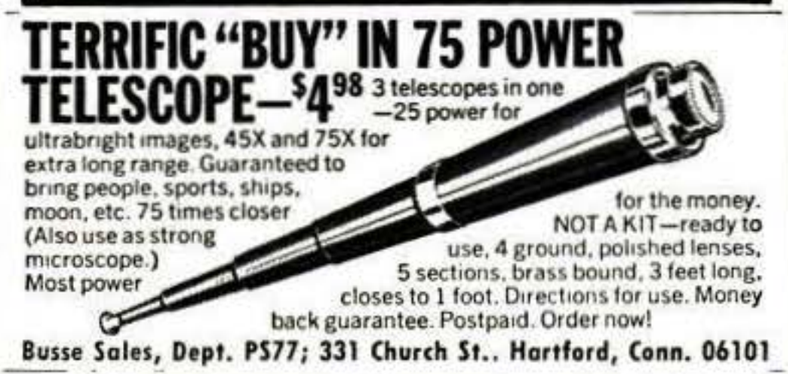

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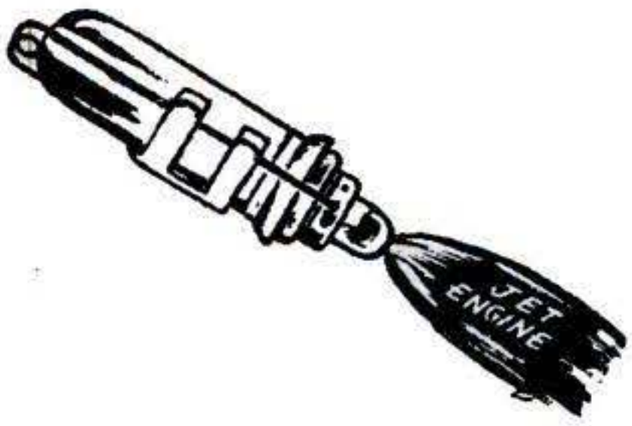

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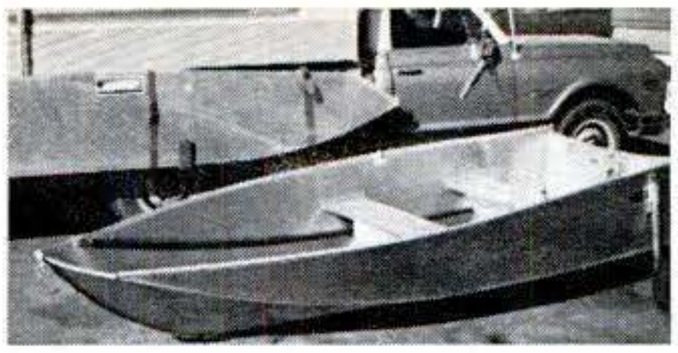

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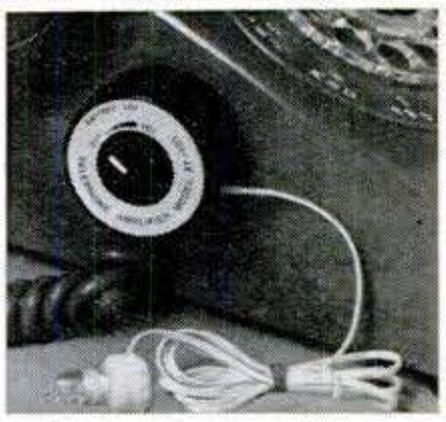

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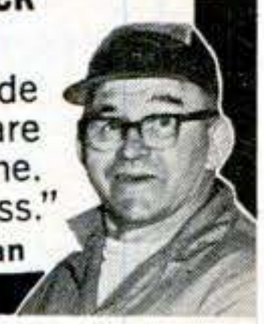

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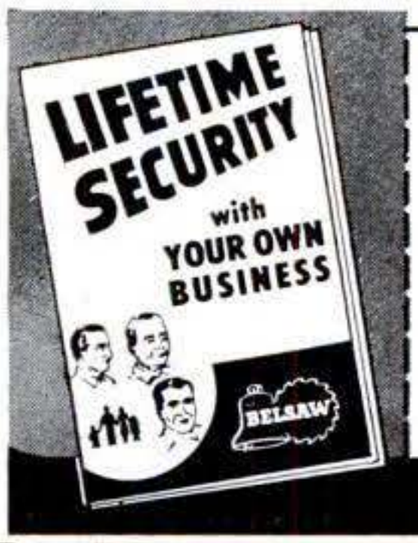

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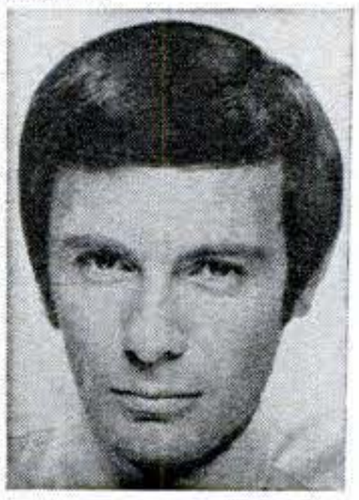

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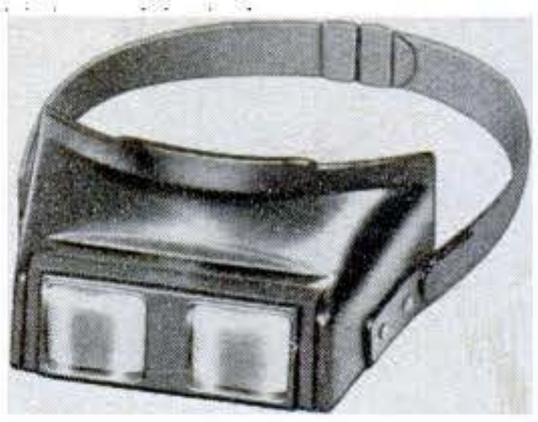

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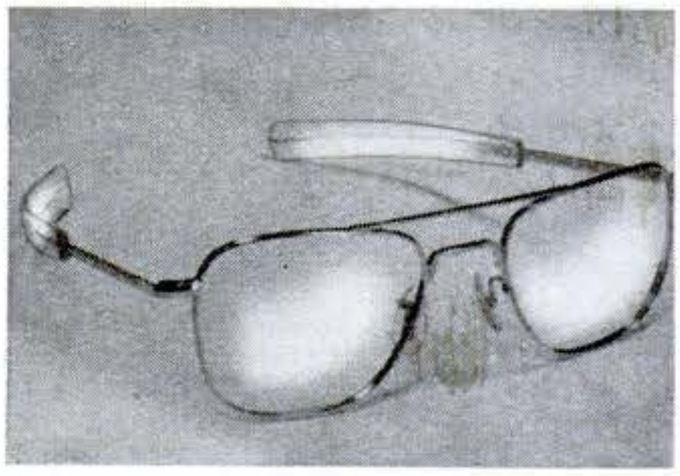

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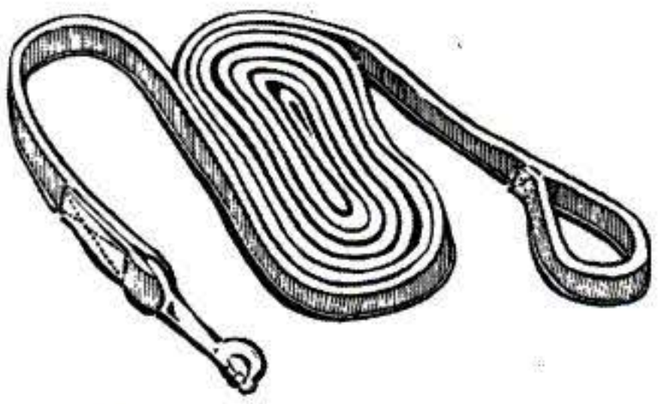

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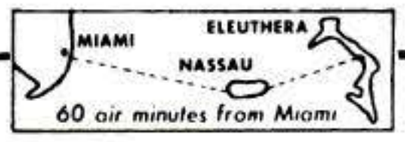

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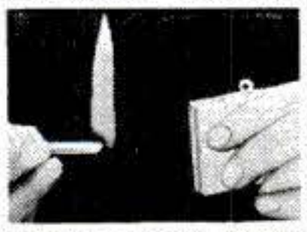

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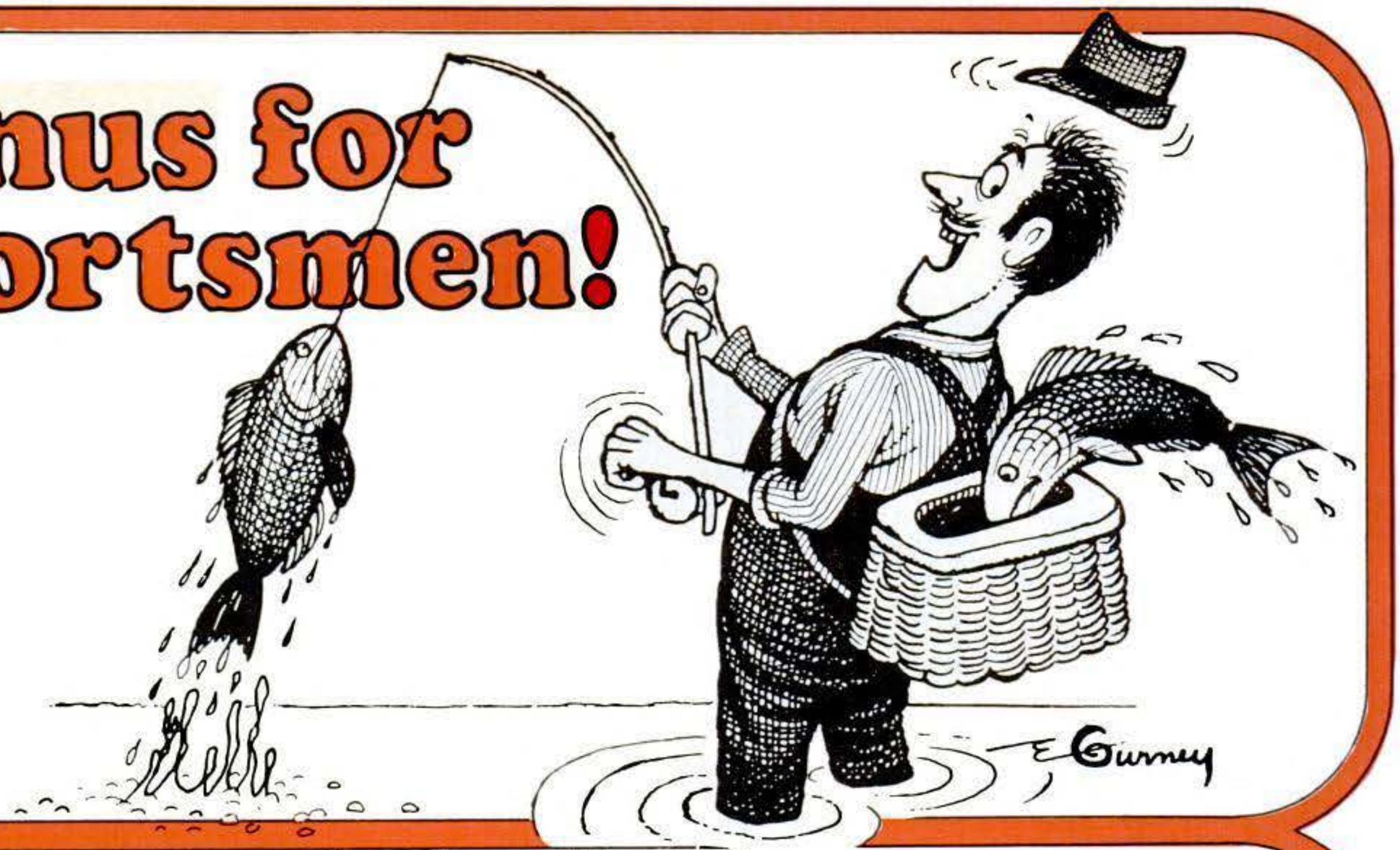

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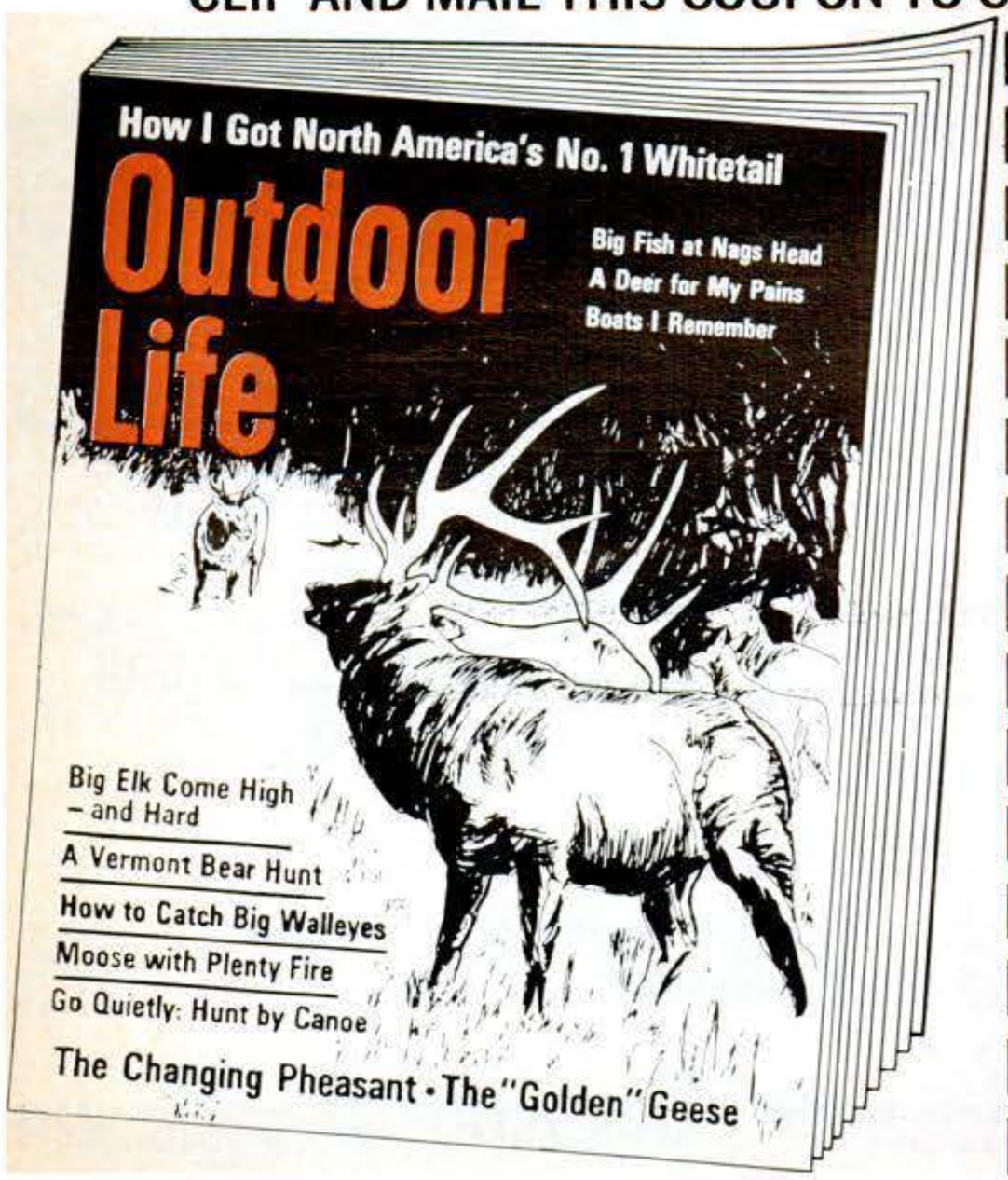

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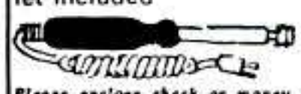

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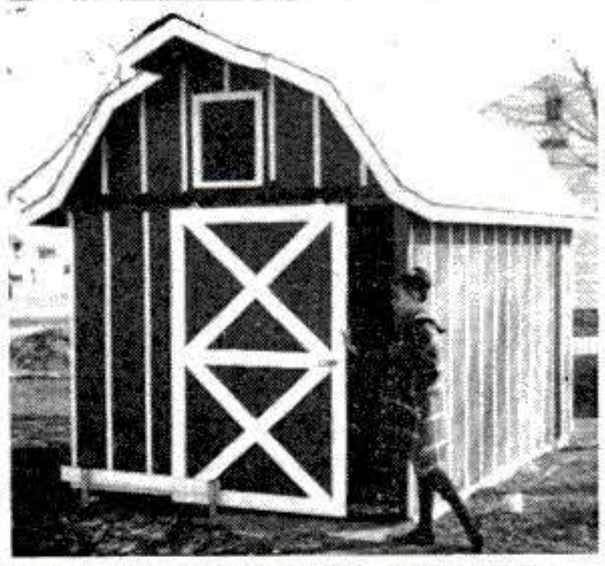

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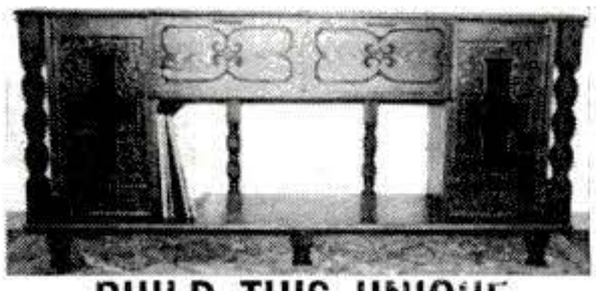

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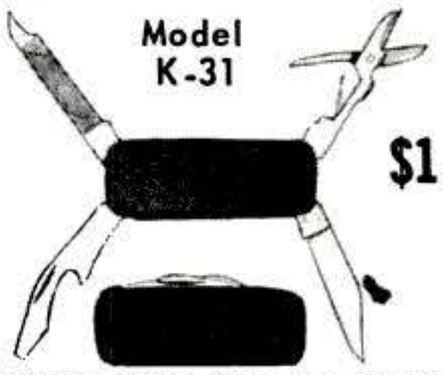

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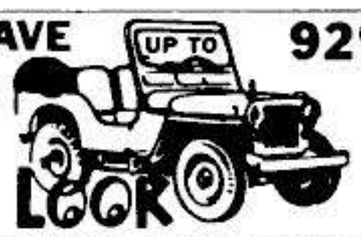

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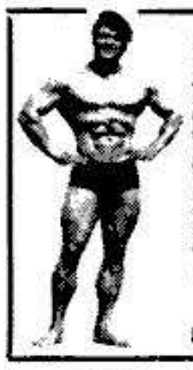

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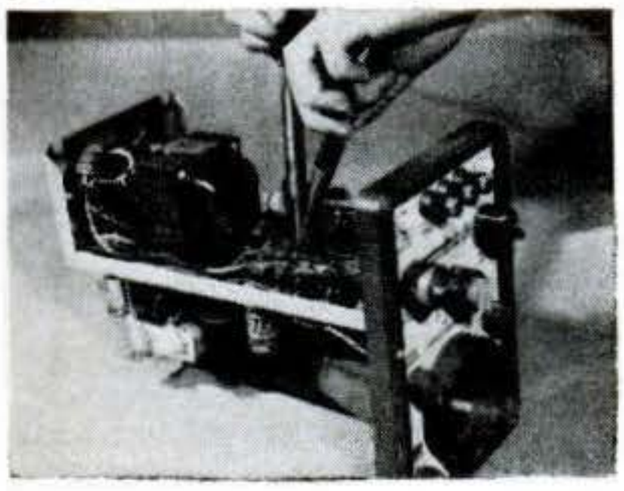

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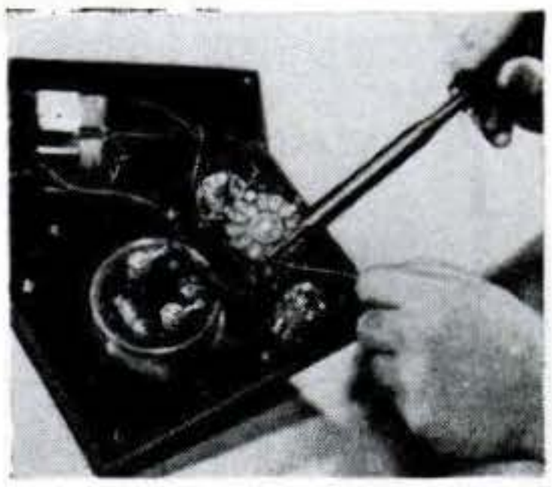

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